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One of the largest electrical companies in this country has developed a new type of illuminating bulb that operates on a minute amount of current.

Do You Need An Extra Bed Room?

One of our leading woodworking authorities will tell you how a spare closet can be reconstructed so as to contain a very practical folding bed.

Two Stages of Tuned R.F.—Regenerative Detector Circuit

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Hotel Kitchen Science in the Home

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One Quart of Gas—22 Tons

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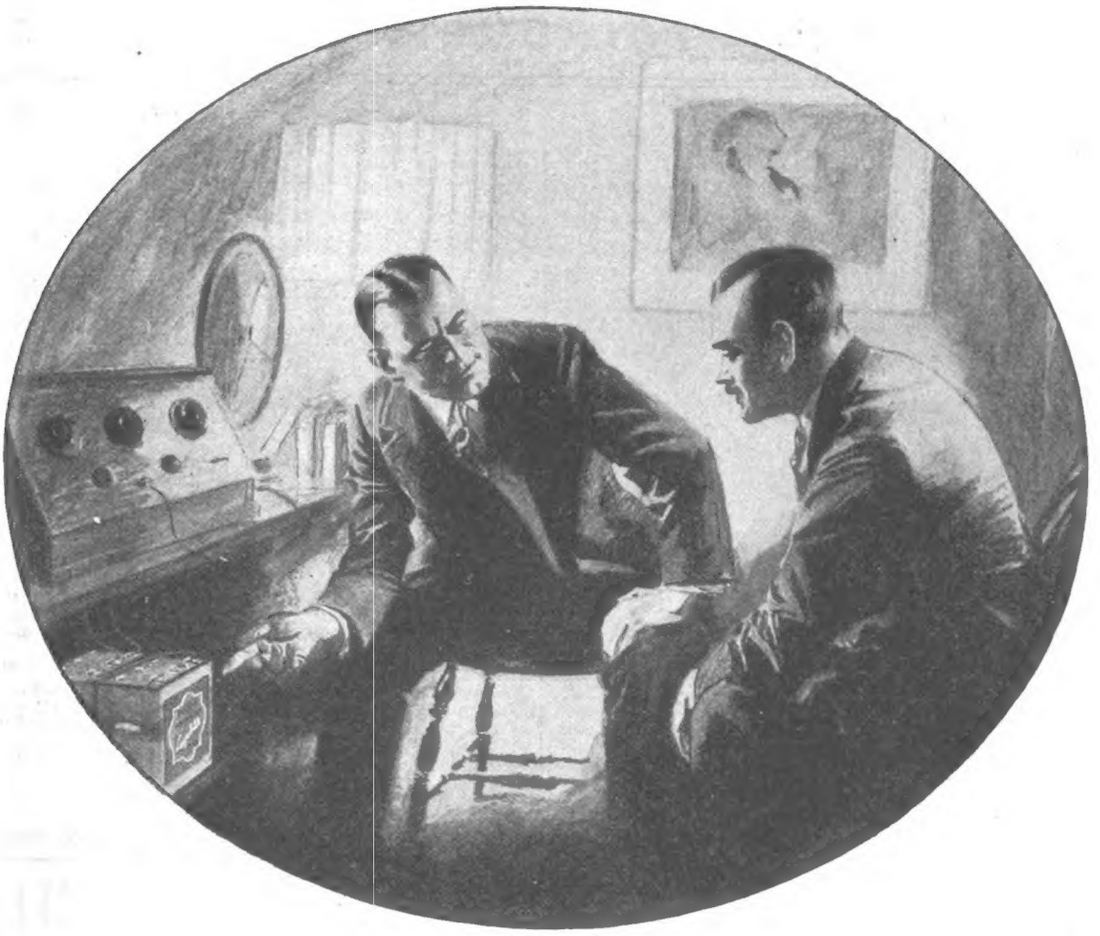

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After all, invention is nothing more than the science of "fixing things." And how many times a day you do "fix things." A leaky faucet, a rattling window, a broken strap — you fix hundreds of things just like these almost every day. You may not know it, but when you "fix things" you are using the principles upon which Inventive Science is based.

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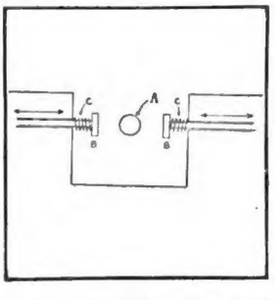
Invention is not guesswork or blind luck—it is not a God-given faculty possessed by a few favored mortals. The truth is that invention is based upon exact laws which anyone can learn. It is merely a matter of first *seeing* something to be fixed and then of thinking of some principle which will fix it. That's all. The whole thing rests on being able to think inventively. The simple problem shown here proves that when you think inventively the whole science of invention becomes as easy to learn as reading or writing.

This test shows how easily you can develop your ability to invent.



Here is an interesting little problem and its solution will be found very simple, if we really think hard.

"A" is the end of a shaft. The two members "B B" are free to move in either direction indicated by the arrows. If they are pushed back, the springs "C C" will immediately pull them forward again. Our problem is to put some kind of an attachment on the revolving shaft "A" so that the members "B B" will be pushed back both at the same instant every time the shaft "A" makes a single revolution. The device on shaft "A" must also allow the two members "B B" to come forward once in every revolution. What would you suggest putting on the shaft "A"?

Why More Inventions Are Needed Now

Hundreds of years ago, the world didn't need many new things. That is why few inventions were made each year. But now the world has more needs, more things to be "fixed." And that is why, in the United States alone, over 50,000 inventions are patented every year!

The world wants better and cheaper light and power. It wants an electric light that will be heatless. It wants new motors that will weigh less and produce more power. It wants faster and less costly aeroplanes, motor cars, steam engines. It wants new inventions which will make cooking and housework easier; that will save time and labor in the home, the farm, the factory and the office. It wants new ideas for toys and other amusements. It wants its present inventions to be developed so that they will work better and more economically.

Surely you have at least one idea for an invention—no matter what it is—no matter how great or how small — the world will pay handsomely for even the simplest idea. Every day you see things which can be improved or which must be "fixed." Every day you can get ideas for new inventions. It can be a new kind of mechanical toy, or some device which will make your wife's housework easier. It can even be something as simple as the common nutcracker. The man who invented the Kiddie-Kar, it is reported, made over $5,000,000!

What Edison Says

Could you ask the advice of any greater authority than Thomas A. Edison? He says: "INVENTION IS A SCIENCE AND SHOULD BE TAUGHT AS A PROFESSION."

And now, for the first time, you can profit by Edison's advice. You can actually learn invention as a profession—exactly as other people are learning electricity, automobile mechanics, law, medicine, as a profession. The Bureau of Inventive Science offers you the first course in practical invention ever devised, it has written down the easy-to-learn principles of Inventive Science so everybody could read them and learn to use them. You want the ability to invent—NOW. All you need, to become successful is this easy, fascinating training which will develop your ability so it will be worth real money.

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Raymond F. Yates, who with fourteen other famous inventors now makes it easy for you to learn how to invent in your spare time at home.

Today fifteen famous inventors tell you WHAT TO INVENT and HOW TO INVENT. They tell you the secrets of invention which every successful inventor knows. They explain how to originate ideas, how to develop and perfect them, how to get patents. But they tell you even more: Thousands of inexperienced inventors have been defrauded of their rewards because they did not know how to protect their patent rights. This great course tells you everything you want to know—how to sell your invention, how to get royalties—how to get the most money for your ideas.

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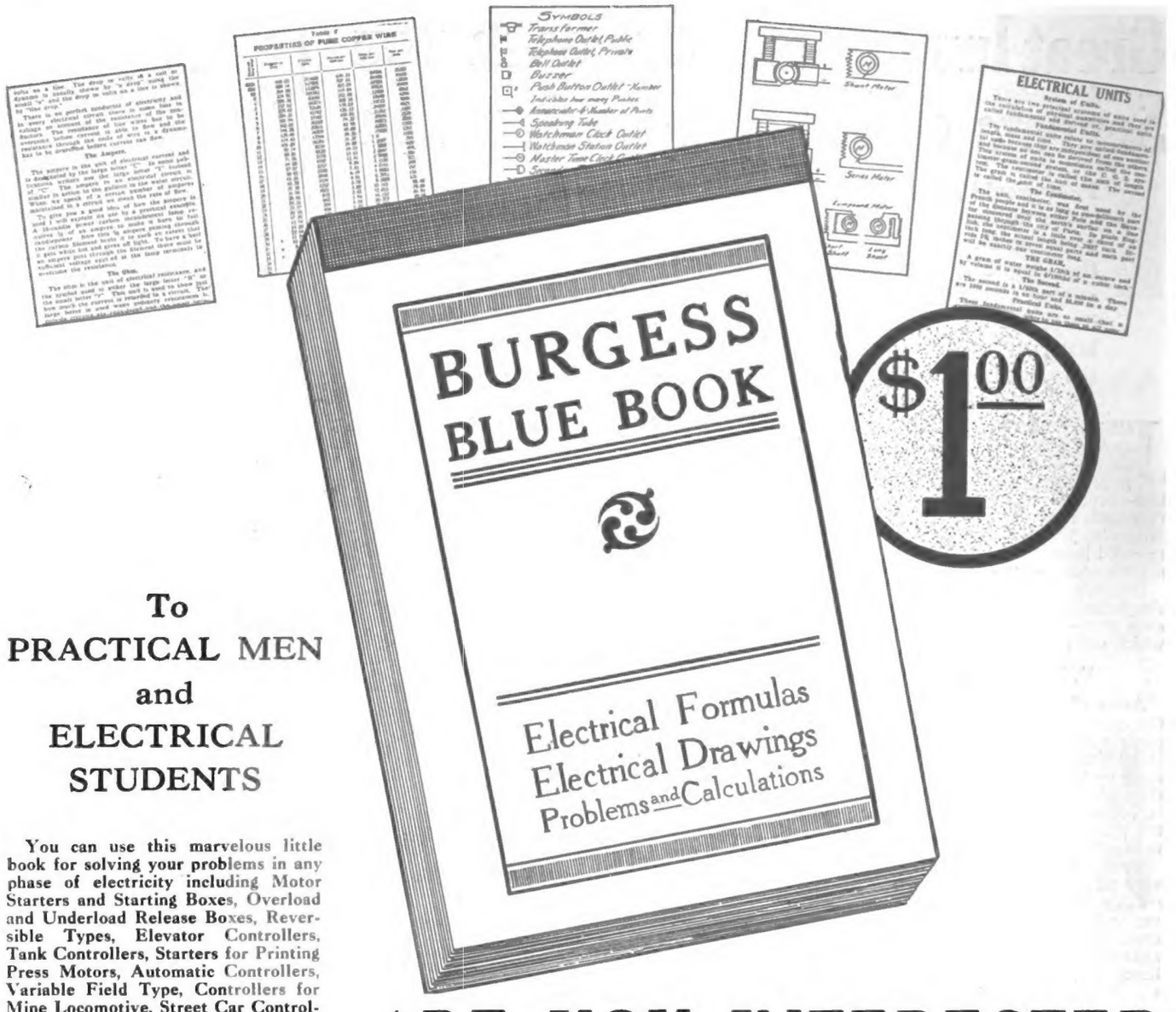

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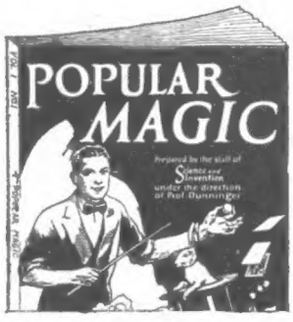

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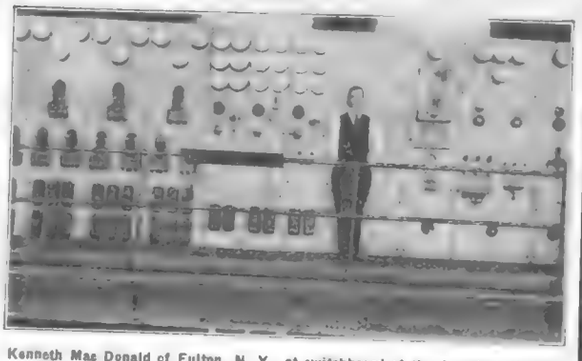

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SUDDENLY the boss turned to me and queried, "Well, Conroy, what's your opinion?" They all listened politely for me to speak and in the silence I heard my thin, wavering voice stammering and sputtering a few vague phrases. Like a flash Stoddard interrupted me and launched on a brilliant description of his plan. All sat spellbound as he talked—my views were forgotton—and yet I have been studying the problem for months and I was prepared to suggest a sound, practical plan which I knew would solve all our difficulties.

And that was the way it always was—I was always being given opportunities to show my ability and always failing miserably. I was bashful, timid, and nervous—I never knew how to express myself, how to put my ideas across. In fact, I was actually afraid of my own voice! Constantly I saw others with less ability, less experience than I being promoted over my head—simply because they had the knack of forceful speech, self-confidence, and personality—the very qualities I lacked.

In social life, too, I was a total loss—I was always the "left-over"—the one who sat back and watched the others have a good time. I seemed doomed to be an all around failure unless I could conquer my timidity, my bashfulness, my lack of poise and inability to express myself.

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What 15 Minutes a Day Will Show You

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"Those Who Refuse to Go Beyond Fact Rarely Get As Far As Fact" - - - HUXLEY

INSTINCT

By HUGO GERNSBACK, F.R.S.

WHAT is instinct? This question frequently arises in the discussion of this most important subject. I shall try in the following to give a popular explanation which necessarily will touch only upon the highlights of this all-absorbing subject.

Instinct is acknowledged to be an impulse distinct from that of reason. Pure instinct, in other words, according to the best thoughts on the subject, *is inherited.* Habit, on the other hand, is acquired.

Suppose you take a dog or a cat who have never seen a body of water before, and you suddenly thrust them into a pond or a river, when both will immediately start swimming towards the nearest shore. They have not been taught swimming so the only explanation is that they must have inherited the ability to swim, which, there being no other explanation, must be the correct and logical deduction.

This same logic holds true throughout the entire animal and insect worlds, wherever we run across the instinct phenomena.

In the human being, instinct is not as strongly developed as in other mammals, while in insects instinct is more highly developed than in all other living creatures. Human reason frequently interferes with instinct, as many researches have conclusively proven. There is an old impression that instinct is possessed only by animals, whereas man reasons. This is not true.

Instinct in man can be suppressed at times, but even the strongest will and the best reasoning do not always succeed in suppressing instinct. Take, for instance, the instinct of self-preservation.

A man makes up his mind fully to end his life by drowning. He has reasoned that he wishes to die, and by his own free will and volition he intends to die by jumping into the river. This he promptly does, but what happens?

In all recorded cases, unless the individual was drugged or otherwise incapacitated, he will immediately, upon striking the water, begin to paddle about, or, in many cases, try to swim ashore. The instinct of self-preservation, in other words, overpowers both reason and will in very many cases.

Fully realizing this, many individuals choose death where instinct can not interfere with the will, such as by shooting themselves in the temple, and otherwise. In that case the act is accomplished so quickly that it is impossible for the reflex system, controlled by instinct, to fight back, once the step is taken. The pressing of the revolver's trigger in this analogy has the counterpart of the act of jumping into the water, in the former example.

In man, the most natural functions are instinctive, such as, for instance, coughing, sneezing, the heartbeat, sex-love and many others, all of which are inherited, and which by no manner of reasoning could be called habit. It is thought that reasoning in the human being *supplements* instinct to a certain extent, which probably accounts for the—to us—high amount of civilization attained by human beings.

In the insect world, as already mentioned, the sense of instinct is vastly more powerful than in any other living beings, and practically all of their so-called reasoning is supplanted by instinct, which thus becomes a sort of automatic, mechanical thinking. We see this particularly in the social life of the ant and the bee, where apparently instinct and intelligence are no longer separated but have become an entity.

It seems that the entire life of all the insects is regulated wholly by instinct, for you can take a few newly born bees which have never seen a bee hive and as soon as they mature they will immediately be able to build their complicated hives, and carry on their existence exactly as if they had belonged and worked in a hive themselves.

The same can be said of the ants and most other insects. Compare these insects to the human being and you will see how far short the human being falls, by comparison. Take the case of a dozen babies abandoned on the most fertile island that you can imagine, where living conditions are all in their favor. This island has everything needed that you could think of—woods, mineral deposits and every other sort of riches imaginable.

What would happen to the babies? Most of them would probably die before they matured, in contradistinction to insects, which would know immediately how to take care of themselves. But even granted that the children grew up to maturity, they would not know immediately by themselves how to build houses like the ones their parents lived in, how to extract ores from the ground, how to make fire arms to shoot the roaming animals, how to build dynamos, how to construct roads, how to subsist from the land in the cheapest and best manner. But this is exactly analogous to what the insects do without ever having been taught any lesson of any kind, without having to read books, and instructions. So, in a way, as many research scientists conclude, the insect must be thought of as far more civilized in many respects than the rest of the world's creatures.

It may even be argued quite correctly that man's reasoning often interferes most destructively with inherited instinct. We often hear the case of an acquaintance who tells us that his first instinct commanded him to do a certain act, but reason stepped in and he did the opposite. Many times it will be noticed that the original instinctive impulse was the correct one, if it had but been followed.

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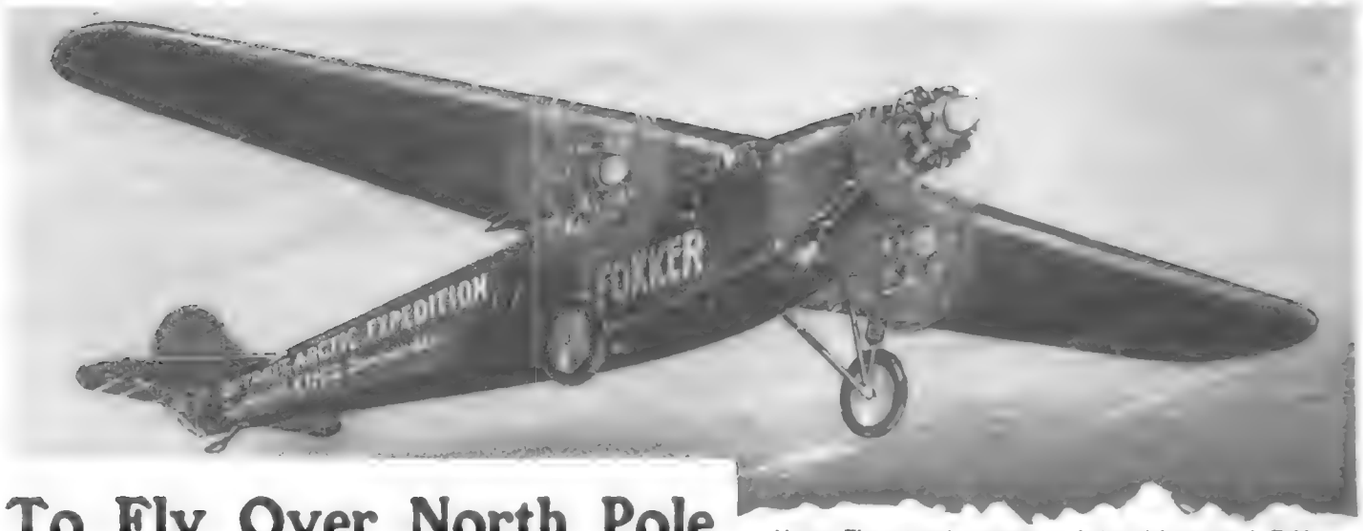
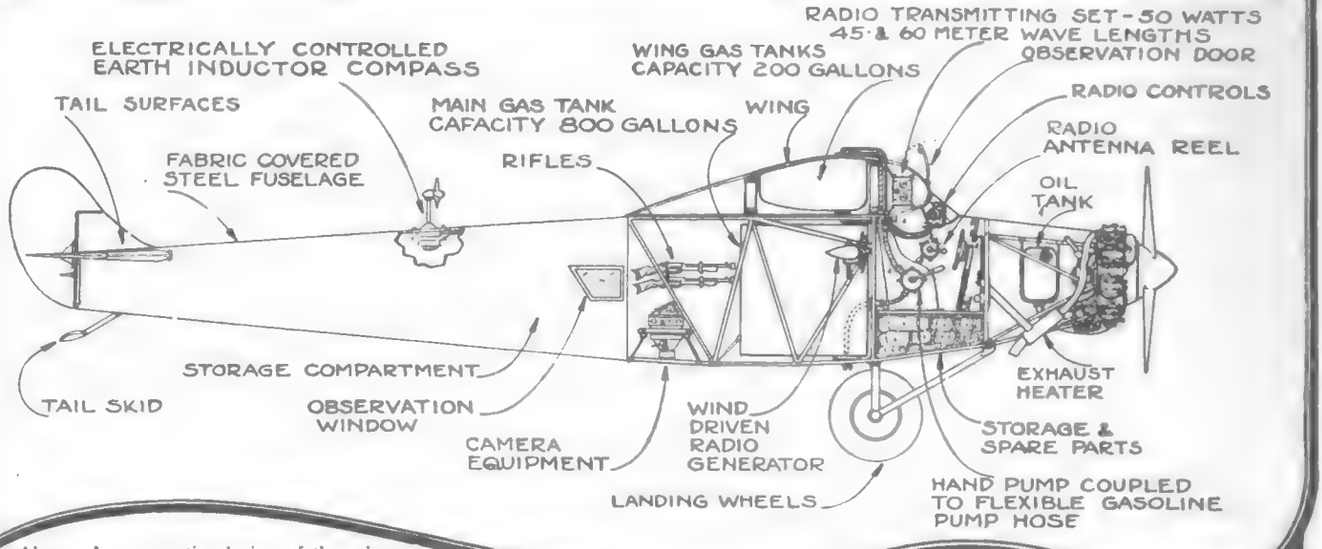
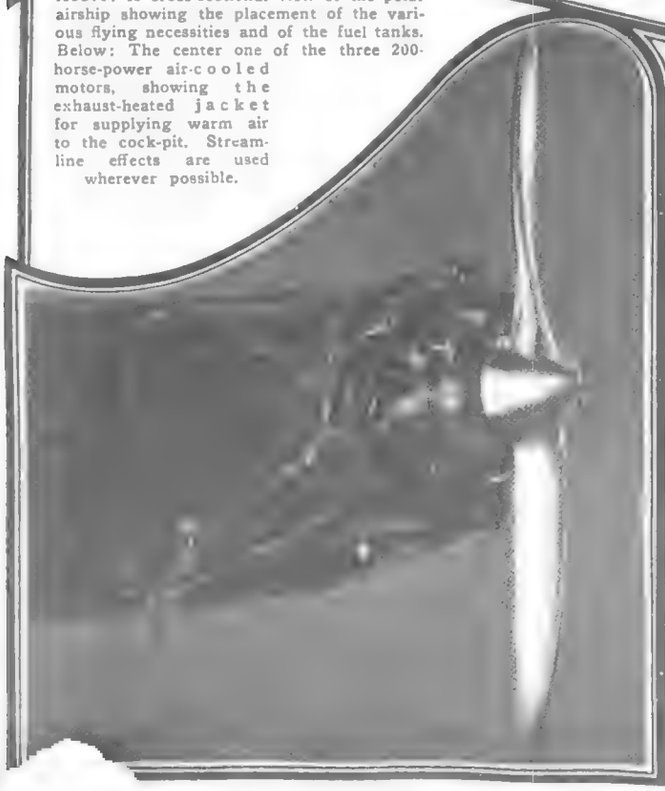


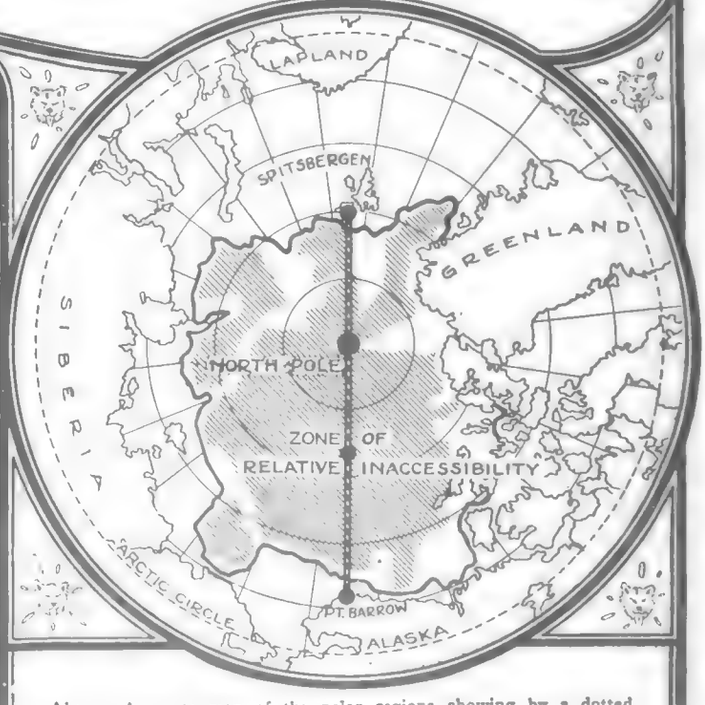
To Fly Over North Pole

Above: The external appearance of the triple motored Fokker plane especially designed for a transpolar flight.



Above: A cross-sectional view of the polar airship showing the placement of the various flying necessities and of the fuel tanks. Below: The center one of the three 200-horse-power air-cooled motors, showing the exhaust-heated jacket for supplying warm air to the cock-pit. Streamline effects are used wherever possible.





Above: Accurate map of the polar regions showing by a dotted line the proposed course for the transpolar flight. It is expected that on this expedition, much information relative to the Arctic region will be obtained, and many photographs taken.

To Conquer Arctic on Wings

By WILLIAM P. SULLIVAN, Aeronautical Engineer.

SOON a little band of courageous men will begin to explore and study the vast open spaces of frozen and unconquered sections of the Arctic. Science plays no little part in making possible this method of exploring inaccessible sections in such a short space of time. Only a few years ago, explorers were forced to travel a-foot with dog teams dragging heavy loads of provisions and equipment sufficient to last for months of hardship in efforts to discover some new lands. Their course covered only a narrow strip because their range of visibility was naturally small due to the fact that it is impossible to see clearly for any great distance from the surface of the Arctic ice.

ENTER AIRPLANE AND MOTOR-SLEIGH

The new method of exploration brings into use the airplane and motor-sleigh. By flying over the section at various altitudes the observer can see within a horizon covering miles in a lapse of a few hours, what would have taken an explorer a-foot with dog teams years to explore. Hence the airplane by virtue of its speed and altitude comes into its own as the great means for speedily and visually placing the previously unknown regions below the observer in the form of a huge relief map that can be studied and photographed for miles. A number of flying bases can be established. These bases would be used for storing airplanes, motor-sleighs, spares, fuel and supplies for extended exploration. By this method it is possible to explore and accurately map by photography the entire unexplored regions of the Arctic.

Of paramount importance and the first item of consideration is the airplane which must be specially designed to withstand Arctic conditions and must be capable of flying for long distances carrying a large fuel supply and scientific equipment. The Detroit Arctic Expedition under the command of Gorge H. Wilkins is using Fokker airliners, one of which is the famous F VII-A three-engined monoplane, which has been stripped of its elaborate cabin furnishings and equipped throughout for the final dash from Pt. Barrow directly across the mathematical pole to Spitsbergen, a distance of 2,100 miles without a stop. The Fokker F VII single-engine plane, while not having the range of the three-motored plane is equipped for transporting supplies and equipment to any bases that might be established and maintaining connections with the main land.

DETAIL OF POLAR AIRPLANE

In designing an airplane for such a long flight and equipping it to cope with the severe weather conditions of the Arctic, many problems have to be solved. The first of course, the airplane itself being of the standard Fokker type, refers to the gasoline system. The engines are the latest Wright J-4 200 horse-power air-cooled type, and the three have an average gas consumption of 40 gal. per hour at cruising speed. This means that for a flight of 2,100 miles at a speed of 100 M. P. H. the gas capacity would have to be 840 gal. This would enable the plane to start from Pt. Barrow, fly directly across the pole, and assuming ideal weather conditions, land at Spitsbergen with empty tanks. But many things have to be taken into consideration, such as head winds, which decrease the ground speed and increasing the distance flown by changing the course for exploration purposes and mapping. To cover these conditions an additional 160 gallons were added giving the plane a further range of 400 miles, or 4 hours at 100 M. P. H.

These figures represent the gas consumption of the three motors at an average of 1,550 revolutions per minute with the plane functioning at its maximum load-carrying condition, but can be considerably increased by the fact that the motors can be throttled back to a slower speed and toward the latter portion of the flight one or even two of the motors can be stopped, or left to idle, the plane continuing on one motor at full throttle. The judicious handling of the motors will therefore add several hundred miles to the range of the plane and add to it a condition most essential, that of prolonged flight with one or two of the three engines throttled or possibly stopped by failure.

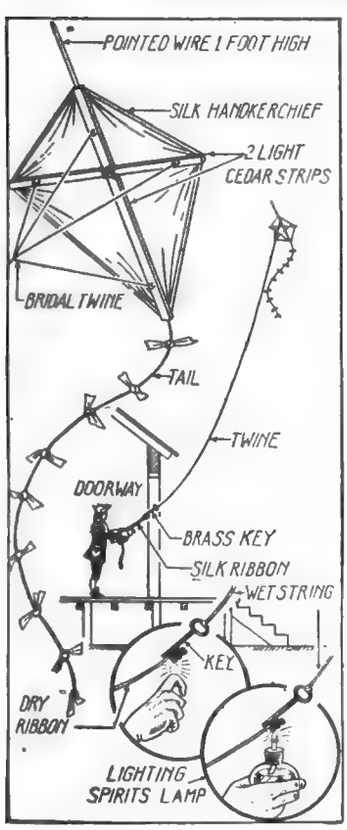
PLANE'S WINGS CARRY GASOLINE TOO

In the design of the gasoline system, therefore a capacity of 1,000 gallons was decided upon. The two standard tanks of the F VII-A are installed in the wing section and contain 100 gallons each, leaving 800 gallons to be carried in a special tank of elliptical shape in the cabin space directly at the center of lift of the plane, so that the balance of the plane will not be changed by the decrease of weight because of the gradual use of this supply, which amounts to 4,800 pounds for a full tank to zero when empty.

This tank was constructed of terneplate suspended by steel straps from the wing fittings and braced in all directions by similar straps for rigidity. The system for feeding the motors is by gravity from the wing tanks which are continually supplied with gasoline from the main tank by a hand fuel pump situated at the side of the pilot's seat. To insure the fuel lines connecting these three units against crystallization, caused by vibration, rubber gasoline hose is used, which also allows the uncoupling of the lines and connecting them with drums for filling the tanks before flight. All vents and con-

(*Continued on page* 70)

Benjamin Franklin's Kite



WORK has recently begun on what will be the world's tallest building when completed. It is being erected between 122nd and 123rd Streets, on Broadway, New York City. It will be 800 feet high, 8 feet taller than the Woolworth Building, as shown in the illustration at the right. This enormous structure will contain a hotel, a church, a hospital and a bank. The architect is William F. Lamb.

DETAILS OF THE KITE

A RECENT controversy was supposed to prove that Benjamin Franklin should not be credited with the famous kite experiment, but investigations have shown that he did actually conduct this work. In a letter written by Franklin, his kite was described in minute detail, as were also his experiments with it. The illustration at the left shows how the kite was constructed from two cross pieces and a silk handkerchief for a cover. Where the kite string is held in the hand, a dry silk ribbon is attached for insulating purposes and the metallic object such as a key is interposed as shown. The wet string outside of the building acts as an electrical conductor and sparks can often be drawn from the key during lightning storms.

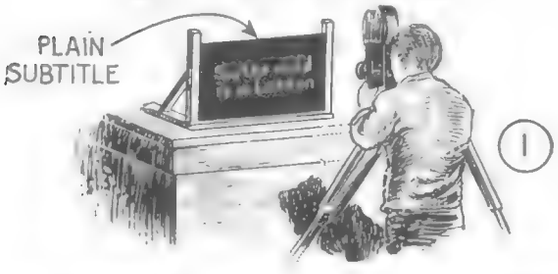
The World's Tallest Building

How Movie Films Are Edited

The Art of Film Cutting and the Making of Sub-Titles Described

By A. P. PECK

Fig. 1. Making a plain sub-title such as will appear on the screen with little or no decoration.



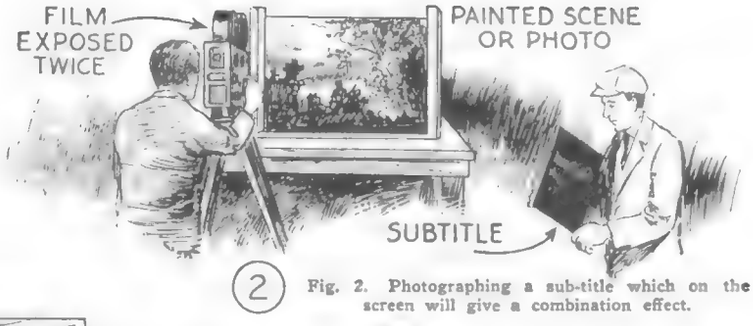


Fig. 2. Photographing a sub-title which on the screen will give a combination effect.

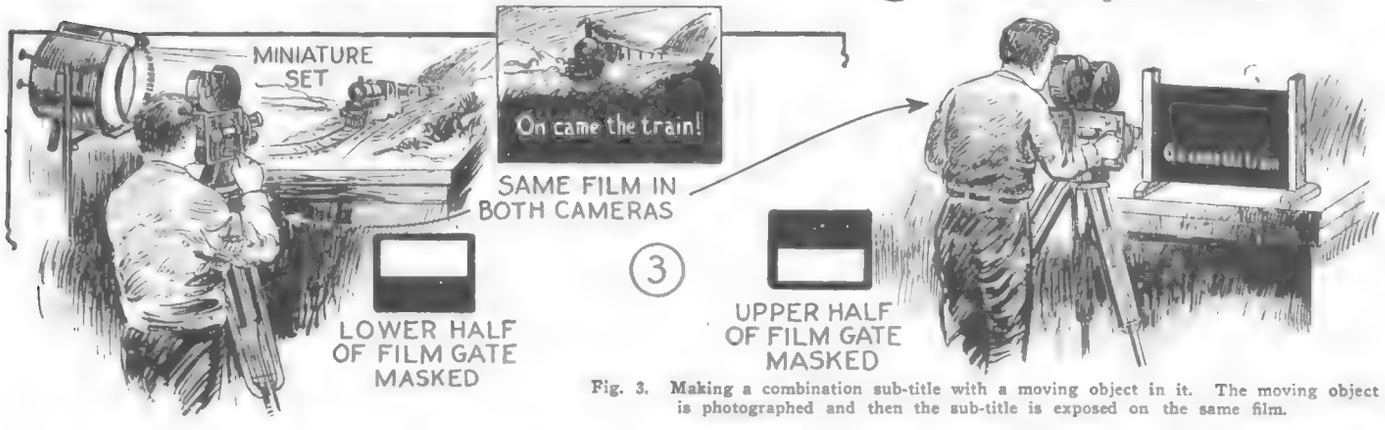
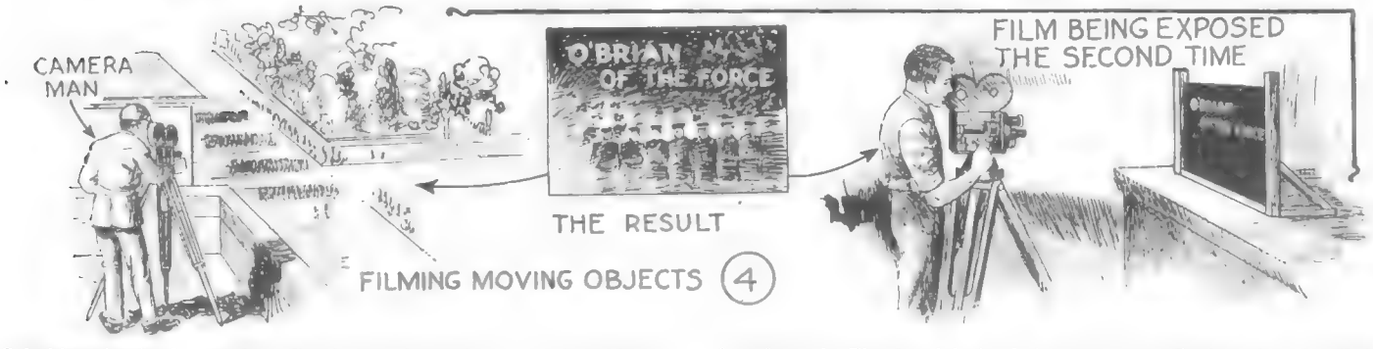


Fig. 3. Making a combination sub-title with a moving object in it. The moving object is photographed and then the sub-title is exposed on the same film.



Sub-titles wherein the actual wording is super-imposed on a moving object are taken as shown in Fig. 4 above. This method is merely another variation of that shown in Fig. 3 and both of them are very effective when the filming is properly handled. Full description given in text.

THROUGH the medium of various motion pictures and periodicals, the majority of us are familiar with the orthodox cameraman and the director who, in the public mind, is the guiding spirit of motion picture production. However, it is seldom that the average person thinks further than these two characters who help in producing his motion picture entertainment, and he generally does not stop to realize that there are other hands that aid in the making of a finished picture. One of the most important of these is the film editor, and in a recent interview with Arthur Tavares, film editor of First National Pictures, Inc., the writer learned many interesting things regarding the duties of these officials, how they work and how motion picture sub-titles are evolved.

Sometimes in the production of an eight or nine reel motion picture, which contains between 8,000 and 9,000 feet of film, Mr. Tavares says that upward of 50,000 feet or more of film are exposed in the camera. It is then up to the film editor and his assistants to cull from this mass of material just that which is most suitable for the making up of the finished picture.

When a large and expensive set is built for the taking of several scenes in the course of the making of a picture, all of the scenes that take place on that set are "shot" at one time, even though not in sequence in the film. Sometimes, particularly when conditions are not just exactly right or when the first scene taken does not seem to be up to the standard required by the director, several shots of the same scene are made. Often as many as six are exposed and each time, the action is gone through.

The illustration above shows the novel film editing machine that saves considerable work in the process of cutting motion picture films.

THE CLEVER WORK OF EDITING

During the filming of each scene, there are several important factors that must be taken into consideration and which must be recorded for the benefit of the film editor who usually is not on the set at the time. For instance, the director, in reading over the scenario and with the set before him, may suddenly conceive an idea which to his way of thinking will produce a more effective scene than that specified by the scenario. He will make these impromptu changes and when the finished film comes to the editor, it will be found to differ from the manuscript of the scenario. Here is where the good work of a so-called *scene clerk* comes in. It is her duty to constantly record everything that goes on in every scene that is taken. Making her notes in shorthand, she has, when the action is finished, a complete record and in fact, what might be called another scenario. She makes notations regarding the costumes of the various actors and records their every conversation. Entrances and exits are caught by her all-seeing eye and recorded. These records are then typewritten on file cards, each card being numbered to correspond with the number of the scene that it describes. At the end of each action or scene, a slate

(*Continued on page* 81)

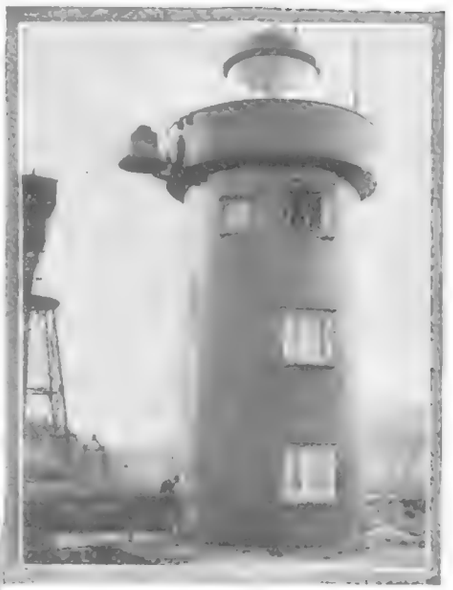
Light Controlled Fog Signal

Light Beam, When Dimmed by Fog, Actuates Warning Signal. Photo-Electric Cell Is Heart of Apparatus.

IN the ordinary order of things under the old regime of lighthouse-keeping, each one of these safety devices required the services of two and sometimes three attendants. Such work, of course, was a constant source of expense to the government operating the lighthouses, and with this thought in mind, Prof. J. J. Dowling and Joseph Mallagh of Dublin have invented an automatic system for operating lighthouses during fogs, using as the main part of their system an interrupted light beam and a photo-electric cell. The various illustrations on this page show in detail the system that is employed. Experimental work has been carried on in the Port of Dublin and on opposite sides of the River Liffey two lighthouses have been erected. One is equipped with a special detecting apparatus and the other with an electric light installation, which projects an interrupted beam of light toward the photo-electric cell on the opposite side of the river.

The light source is so constructed and equipped with lenses that the beam of light is focused and concentrated on the photo-electric cell one-quarter of a mile away and the detecting cell is in turn connected to a vacuum tube amplifier and a relay. At the light source, a slotted disk is driven by means of a motor and so arranged as to interrupt the light beam 500 times per second. This is done so as to send a pulsating current from the photo-electric cell to the vacuum tube amplifier.

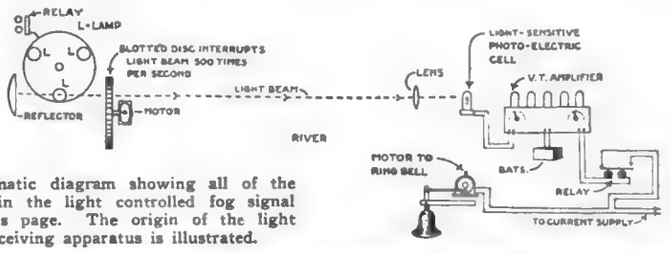
The operation will now be obvious to the reader. As long as there is no fog between the two lighthouses, the photo-electric cell is actuated by the light beam and in turn, the relay is held open. However, when the light beam is obscured by fog, the photo-electric cell ceases to operate and the relay closes its contacts. In turn, a motor is actuated which causes a fog bell to ring until the fog decreases to such an extent that the light beam again reaches the photo-electric cell and the relay opens. As shown, several lamps are employed, so that when one automatically burns out, it will be replaced by another. This is accomplished by means of a very ingeniously designed relay which releases the rotary platform on which the lamps are mounted and allows it to turn through one-third of a complete revolution, placing another lamp in position for operation.



Above: A view of the light house at the receiving end, where the photo-electric cell and the fog warning apparatus is located.

Above: The lamp installation and the slotted rotating disk at the transmitting end of the new light fog signal system.

The seven-tube amplifier connected between the photo-electric cell and the relay is shown above.



Right: A simplified schematic diagram showing all of the principal apparatus used in the light controlled fog signal described in detail on this page. The origin of the light beam as well as the receiving apparatus is illustrated.

This drawing shows just what happens when fog sets in and the light beamapproaching vessels. No attendants are necessary at either end as the is interrupted. Immediately the fog signal starts to sound and to warn entire operation is completely automatic, thanks to applied science.

Science Checks the Spirit Medium

By EDWARD MERLIN

The Reformed Spiritualist.

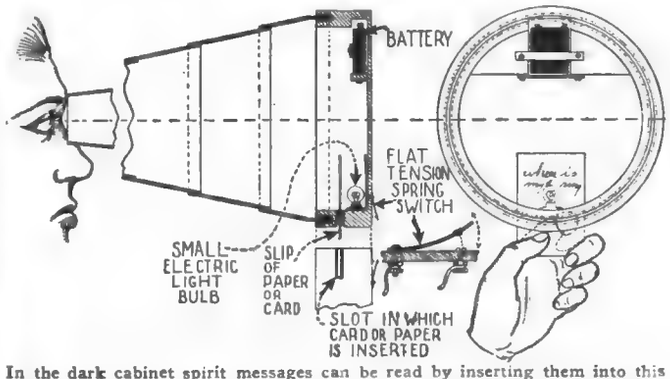
If all spiritual mediums that produced manifestations in the dark were to be painted with luminous paint insignias unknown to the mediums, and were the paint to be applied to the bare skin, such things as manifestations would not occur.

Mr. Merlin has for years given seances. He is positive that such a thing as a spiritual manifestation has never been produced and that all mediums that operate for pay are fraudulent. His past articles in this publication show that he knows his work. This is another of the series, and exposes some more of the tricks of these arch fiends preying upon the gullible public; upon widows, mothers and orphans. Remember Science and Invention and Joseph F. Rinn still have $11,000.00 which they will pay for genuine phenomena.

ON this page is shown a number of spiritual effects which are done by spirit mediums throughout the country. When these methods are illustrated in a magazine article the statement is generally made by those reading the articles that they could never be fooled by methods so crude and simple. The truth of the matter is that the spirit medium is inferior to the average conjurer when it comes to effects or skill. The medium works in the dark and consequently does not fear detection. She knows that she can get rid of her horns or "gimmicks" quicker than the eye can be accustomed to light; and should a flashlight be turned upon her suddenly, there would be plenty of witnesses to testify that the horn was in mid-air when the flashlight was ignited. If in every spirit seance care were taken to see to it that only the medium herself produced the manifestations, and if all these mediums were painted with radium-luminous signs applied directly to the skin, those signs would in no way impede her manifestations, but she would also be unable to accomplish any effect without fear of detection. If luminous signs are painted on strips of adhesive tape, the adhesive tape can be removed and again replaced.

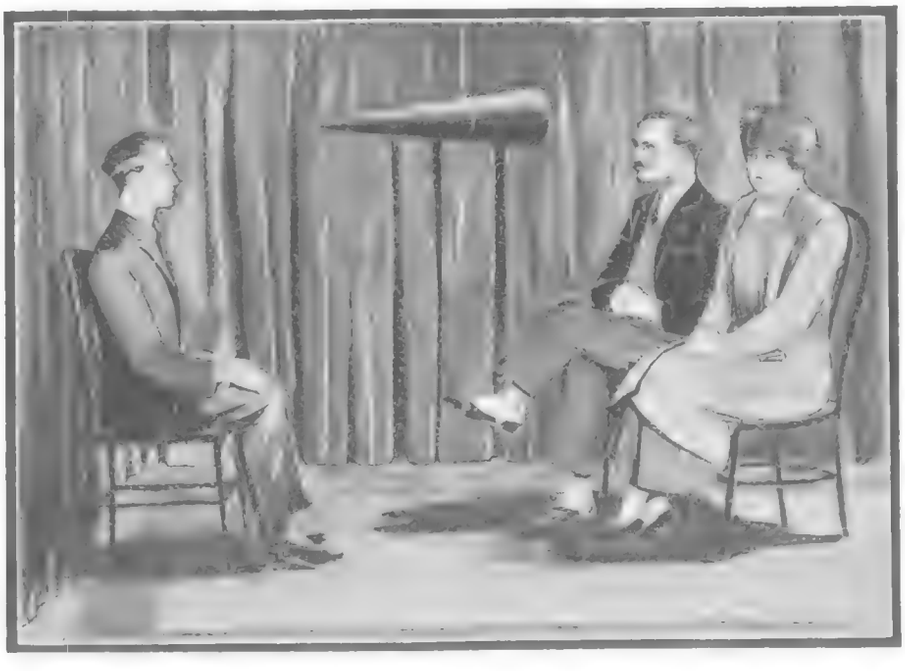
Other effects are explained in the drawings.

In a dark cabinet a medium finds it quite easy to insert a black rubber tube into the end of the horn and cover his hand up with a black sleeve, manipulating the hose, causing the horn to move, and talking into the hose whenever he desires.

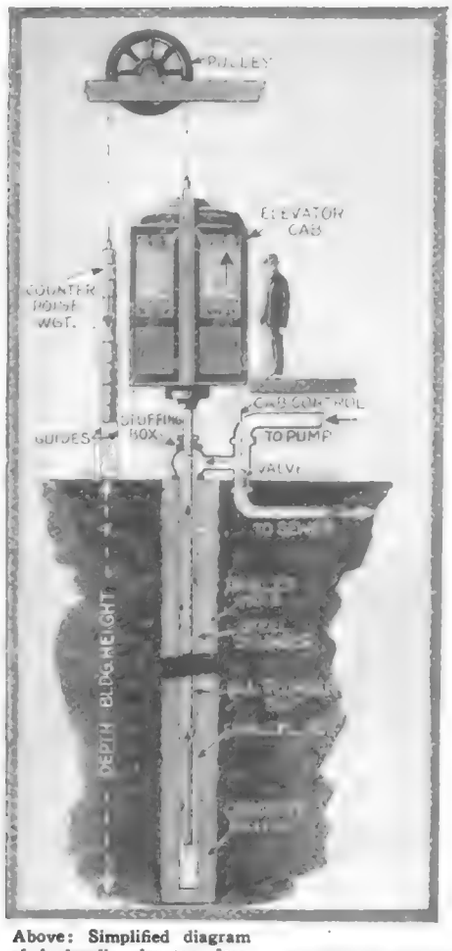

BATTERY
FLAT TENSION SPRING SWITCH
SMALL ELECTRIC LIGHT BULB
SLIP OF PAPER OR CARD
SLOT IN WHICH CARD OR PAPER IS INSERTED

In the dark cabinet spirit messages can be read by inserting them into this light-containing cover for a spirit horn. The envelope in which the message reposes is smeared with alcohol to make the envelope transparent.

A medium with a luminous band on each wrist and one around his forehead sits in the position indicated at the right. When the lights are extinguished the bands are removed and placed on the medium's legs as indicated above. A collapsible trumpet is taken from beneath his vest, unfolded, fitted to the suspended trumpet as shown, and serves to direct the voice to the trumpet hung in mid-air.



The Romance of Hydraulic Elevators

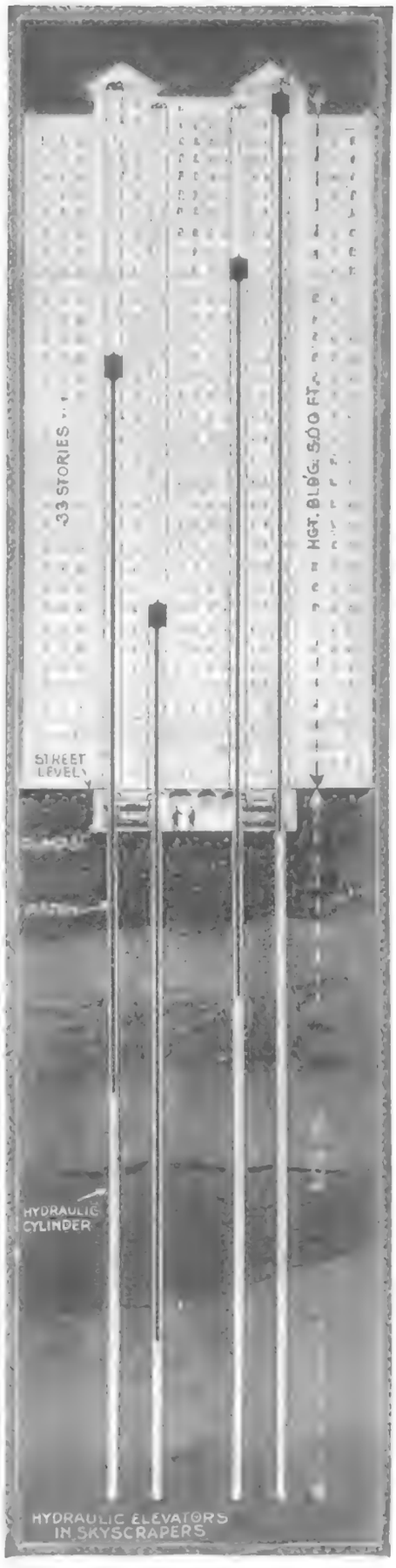


Above: Simplified diagram of hydraulic elevator, less safety devices.

IT may seem strange to head an article dealing with such a prosaic subject as elevators with the title including the word "romance." However, the subject really has its romantic side just the same as bridge building and other feats where Nature becomes a constant enemy of the constructor. Remember that wherever an hydraulic elevator is built, it is necessary that a hole be drilled in the earth to a depth equal to that to which the elevator will rise above the surface of the earth. As shown in the illustration at the extreme right, where it is necessary for an elevator to reach the top of a 500-foot high building, the elevator shaft must be driven into the earth 500 feet below the surface. Not only must this be done, but it must be accomplished with absolute accuracy. Although the finished hole, exclusive of the concrete filling as illustrated at the left, is only a little over a foot in diameter, the construction of these cylinders is completed with wonderful accuracy.

Not only must the hole or cylinder be perfectly straight, but the shaft within the cylinder must be as accurately made. It is obvious from the drawing at the left how these elevators operate. They are actuated by the well-known physical law wherein it is stated that pressure in water is distributed equally in all directions. Therefore, when water is forced into the cylinder by means of the pump, under a pressure varying from 100 to 500 pounds per square inch, the base of the plunger is pressed upward and the car is caused to rise. When the valve controlling the water from the pump is closed, the weight of the car causes it to descend, forcing the water out of the cylinder.

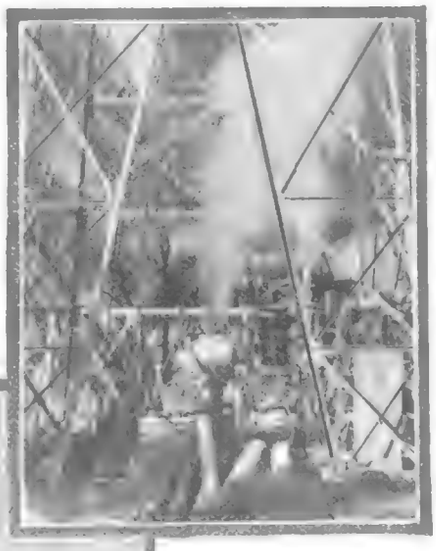
It has been attempted to use telescoping plungers, but they have not been successful.



Above: This cross-sectional view shows how the cylinders for operating hydraulic elevators must be drilled deep into the earth.

Harnessing Natural Steam

Below: One steam geyser in full operation in the foreground and another one just beginning in the background.



Some enterprising engineers are just beginning to tap certain natural sources of steam and the photograph at the left shows some of the apparatus used for this purpose. The method used for obtaining steam from natural sources is to drill a well, in much the same manner as an oil well is drilled, to a depth of from 200 to 500 feet, inserting iron steam pipe castings with large control valves. Steam at a pressure as high as 150 pounds per square inch is often obtained.

There are certain places throughout the world where natural power from underground steam sources is available and one that has recently been commercialized is located in Geyser Canyon, California. The method of harnessing this power is shown in the photograph above. The steam obtained by drilling wells and controlling the output can be used for any purpose to which artificially generated steam can be put. It is said that various foods can be cooked over the outlet of one of these steam wells. Another place where terrestial heat has been utilized is in Italy where the volcano Vesuvius has been tapped.

The Origin of the Earth

By PROF. DONALD H. MENZEL, Ph.D., Ohio State University

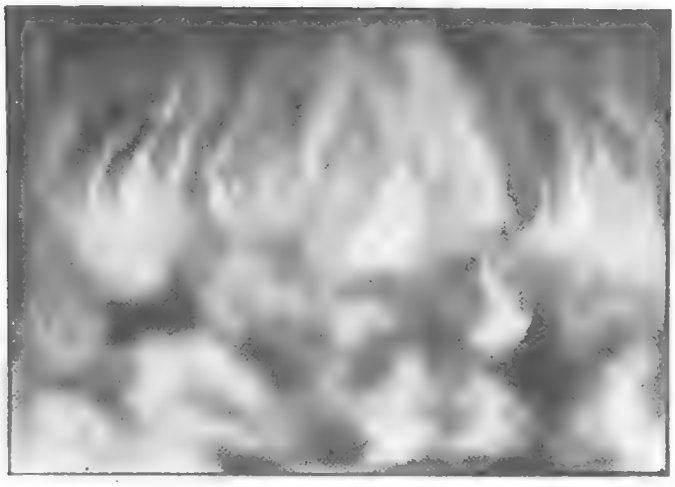


Fig. 7. It was once assumed that at one time, the universe consisted of a mist of fire which might have taken the form shown in Fig. 1 at the left, and that as this mist contracted and became cold, it formed the sun. This theory is no longer generally accepted but it was a good starting point for the studies of later astronomers.

THE first attempt at explaining the solar system as the result of an organized evolution rather than by chance appears in the philosophy of Kant. He assumed that at one time the entire universe consisted of a "fire-mist" which contracted as it became cold—thus forming the sun. (Figure 1).

Kant's philosophy was of great value chiefly in that it started men thinking upon the problem. He had assumed that the forces of chemical attraction had caused the rotational movement. Laplace, the famous mathamatician who made the next improvement, though it is evident that he was not familiar with the previous theory of Kant, did not put forth his ideas with the same degree of assurance with which they were subsequently affirmed by his followers and, though we no longer accept it, the Nebular Hypothesis played a great part in the history of astronomy.

(Figure 2). Like Kant, he assumed the presence of an extended nebula of hot gas but his adherents generally reversed the order of creation by assuming the gas to have been cold. This is more in accord with the modern laws of physics. As this gas contracted under its own force of gravity the pressure within increased. Higher pressure causes heat and the process continued until the mass became faintly luminous and a star was born. In conjunction with the contraction an increasingly rapid rotation would cause the mass to become highly elliptical until a ring was thrown off. Further contraction would bring about the same unstable condition again and again—each ring itself condensing into a planet.

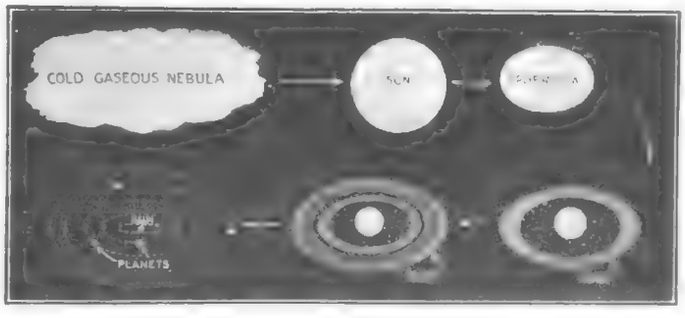


Fig. 2. A later hypothesis put forth the idea that the original universe was a nebula of cold gas and that as it contracted, due to gravity, the heat increased and eventually the sun and the solar system was formed.

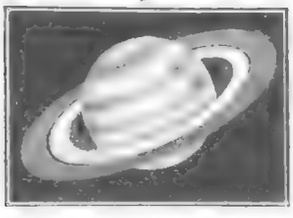


Fig. 3. Later on in the course of events, planets, according to Laplace, might throw off rings which eventually would condense into small heavenly bodies. This is evidenced by the asteroids discovered near Mars and Jupiter.

(Figure 3). Laplace also pointed out the possibility that each planet might subsequently throw off rings which would condense into satellites. As proof of his theory he pointed to the rings of Saturn, known to be made up of relatively small bodies, suggesting that for some reason or other, they did not collect into a larger body. The finding of about a thousand asteroids, small planets lying between the orbits of Mars and Jupiter, was additional evidence.

Fig. 4. Laplace's theory was somewhat discredited when it was found that a satellite of Saturn revolved around that planet in the opposite direction to that in which it should travel under the theory of Laplace.

One necessary consequence of this theory was that all the satellites and planets must revolve about the sun in a given direction. The discovery of Phoebe, a satellite of Saturn, which moved in the wrong direction, as well as some of the other moons of the outer planets, served to throw some doubt upon the once well-established theory. (Figure 4).

Laplace had advanced his hypothesis "with that distrust which everything ought to inspire, that is not a result of observation or calculation." It is not to his discredit, therefore, that the rigid application of mathematics to the problem has not borne out his theories. Since, according to the well-known law of the conservation of energy, the amount of energy in the solar system is constant, and since Mercury was the last planet to be formed, the sun, when it threw off that planet, must have been rotating with a period of 88 days. When we compute the energy of an object rotating with that period and with the neessary size, we find that it would have many many times the energy actually possessed by the sun and Mercury at present. Similar contradictions between fact and theory are met with at every step and all scientists now regard the nebular hypothesis as absolutely untenable.

An entirely different view was taken by Chamberlain and Moulton in developing their so-called Planetesimal Hypothesis, which is accepted today as having certain undoubted elements of truth. They believe that at some time in the remote past, our sun came very close to another star. As a consequence, terrific tides were raised upon each of the two bodies and large quantities of material were spouted forth. This soon cooled and condensed into smaller particles—planetesimals. Certain of these, slightly larger than the rest, proved to be the predominating influence in the system. By collision with the other smaller particles they grew by accretion until they finally came into their present orbits. (Figure 5).

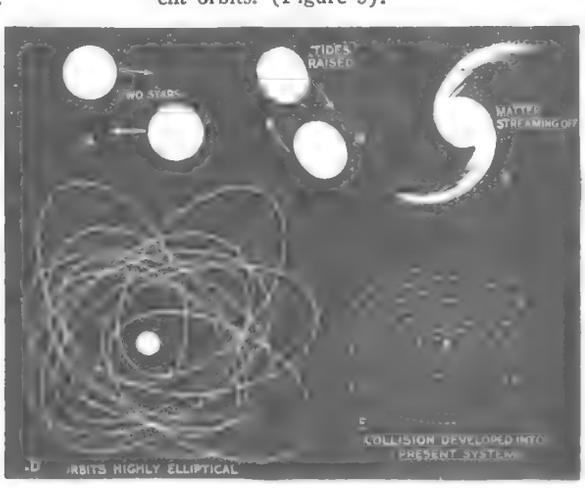


Fig. 5 at the right illustrates the so-called Planetesimal Hypothesis which is partially accepted by the astronomers of today. This stated that the sun and a large star came close together as at A, tides were raised as at B and soon particles streamed off as at C, eventually passing through the state at D and forming the planetary system as at E.

Certain objections have been raised against this theory as well, leading to the formation of a modification, known as the Jeans-Jeffries theory, since these two men have had more to do with it than any others. They adopt the above viewpoint, namely the near

Fig. 6. The Jeans-Jeffries theory of the formation of the planetary system is illustrated above and described in this column.

approach of two stars, but calculate that the tides would have produced a long drawn-out filament (Figure 6) instead of the planetesimals. The point of ejection would have always pointed toward the star and the amount of matter in it would have been greatest when the two stars were nearest. Thus, the filament would be tapering at both ends and densest in the portion nearest the sun, for that fragment had its origin in the lower layers of the sun's surface. This filament would cool and finally break up into planets. Not only the general distribution of size, Jupiter the largest and Saturn, next to the largest, being near the middle, but also the distribution of density, the innermost planets being the densest, is accounted for. It certainly took place more than a billion years ago and probably not more than 4 billion years ago, but the exact time of the catastrophe is difficult to fix.

This hypothesis last described, usually designated by the name "Tidal Hypothesis" meets many of the objections which can be set agains the Planetesimal Hypothesis. For example, it is difficult to see how such small and widely scattered particles as the planetesimals ever could have been aggregated into the present system, especially when it is probable that the force of their collisions, instead of leading to a gathering together, would probably have tended toward further disruption.

One of the main supports for the Nebular and the Planetesimal hypothesis has recently been torn down. Laplace thought that the spiral nebulae were solar systems in the making. Modern research, however, shows that they are much larger and the most recent work has proved that they are systems of millions of stars, so far away that light takes about 1,000,000 years to reach us from them. Each tiny knot in the arms of the spiral pictured above is thousands of times as large as our own solar system.

Most of the satellites of the various planets can be accounted for by capture or a simple tidal pull on the planet. It is probable, however, that our own moon did not originate in such a manner. At some time in the history of the Earth, some outside force, presumably the sun, caused it to be disrupted into two pieces, one of which subsequently became the moon. The theory is too detailed to be more than mentioned here and will be treated in a subsequent article.

THE DUALISTIC THEORY

A New Hypothesis for the Origin of the Solar System

AN old philosopher once said, "Any theory, be it right or wrong, as long as it stimulates thought, is of value to science." Of all the problems which have received the attention of man, perhaps one of the most perplexing is that concerning the origin of the solar-system and its attendant parts, and, in spite of the varied nature of the resulting hypotheses, each has played a part, and an important one, in the advance of modern civilization which has its foundation in knowledge as

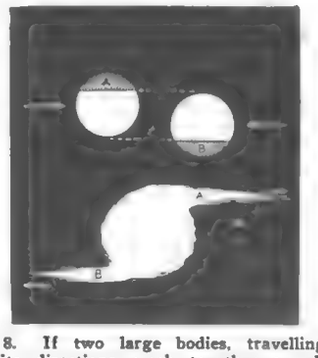


Fig. 8. If two large bodies, travelling in opposite directions crash together as above, two streams of matter, A and B, would be thrown off and thus a solar system might be started.

distinguished from the superstition of the dark ages. During the past decade, our progress has indeed been rapid and many new theories have been brought to light.

Among the very newest of these may be

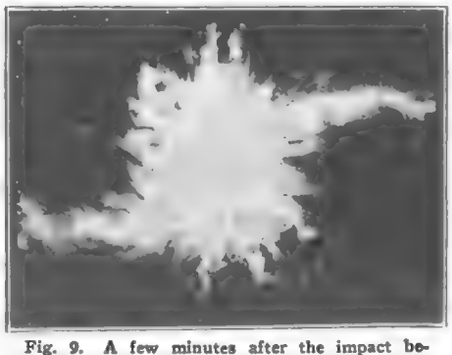


Fig. 9. A few minutes after the impact between two huge heavenly bodies. Note the large streamers spreading out to the left and right. The Dualistic theory.

found the "Dualistic Theory," a system propounded last December by Col. John Millis of Cleveland, a retired army engineer, to the members of the American Association for the Advancement of Science. Col. Millis

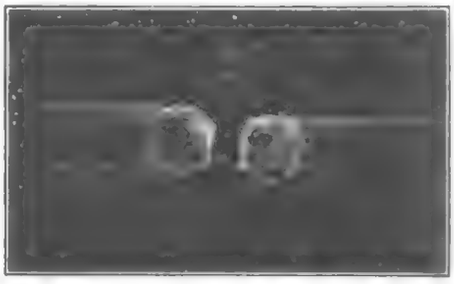


Fig. 7. Here we see two bodies hurtling through space at a tremendous speed and about to collide with each other. The result might be as shown in Fig. 8.

hoped to establish a new system for the creation of the sun and planets, among them the earth.

Space is known to be full of dark matter —nebulae, meteors, and probably stars which have run their course, faded, and become cold. Col. Millis pictured the process of the collision of two such objects, each about half the size of the present sun. (Fig. 7.) The velocity of each object would be sufficient to cause their complete coalescence into a single body, but not sufficient to cause a complete disruption and subsequent dissipation into space. The collision was supposed to have been almost, but not quite, "head on." This condition is illustrated in Fig. 8, showing how there would be a tendency of a certain quantity of the material to spatter out and move in approximately co-planar orbits. The force of impact would probably be sufficient to account for the present temperature of the sun.

The result of this primal cataclysm was the sun, surrounded by a quantity of matter rotating in highly elliptic orbits and in approximately the same plane and direction. From this point, the theory follows in general the main outlines of the well-known Planetesimal Hypothesis — the fragments gradually collecting into larger bodies by collisions and coalescence. He suggested that the large depressions which now contain the terrestrial oceans were caused by the impacts of planetesimals of very large size.

Whether or not this theory will meet with general acceptance or not is of little moment. It certainly has a greater degree of probability than the old nebular hypothesis which our forefathers swore by. The fact that it is *not impossible* is the important part of any theory and, while it appears to the author that there are several outstanding objections to it, we at least welcome it as a stimulus to the imagination and perhaps it will lead us to further investigation of certain parts of the planetesimal hypothesis which have recently been placed in a cloud of uncertainty.

Chromium New Reflector

A new reflector that is as efficient as a freshly silvered glass mirror, that will not tarnish or corrode when exposed continually to the weather, and so hard that the surface can be cleaned with gritty waste without scratching, was described by Dr. Robert J. Piersol, research physicist of the Westinghouse Electric & Manufacturing Company, in a paper read before the Illuminating Engineering Society meeting at Detroit.

The new reflector has a surface of polished chromium, and was developed by Dr. Piersol in his search for one that would be satisfactory for use on automobile headlights and outdoor flood lights.

Glass backed with a silver coating, now the best reflector of light in common use, is not practical for these two purposes, as it is extremely fragile and the cost of its manufacture in the larger sizes is prohibitive.

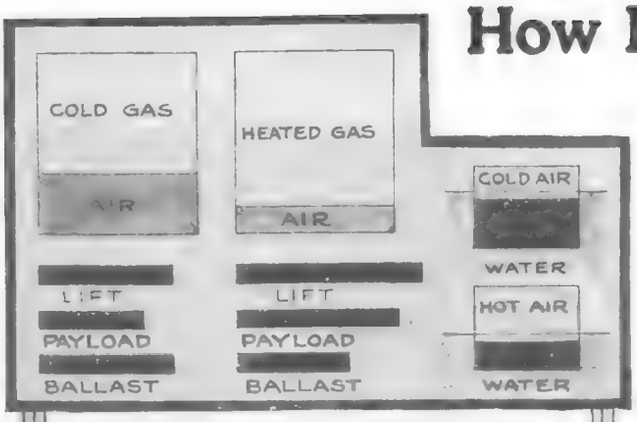
Strangely, although chromium is one of the most brittle metals known, it is very ductile when plated as a thin coat. This is shown by bending a strip of chromium plated copper repeatedly. The strip may also be heated to a red temperature and quenched in water without the chromium plate scaling from the copper base.

The surface of the chromium plate is of tool steel hardness and it is difficult to scratch it with a pin or knife. In fact it is possible to wipe the dust from a chromium plated reflector with gritty waste without injury to the polish of the reflector. Ordinary emery grinding compounds would not touch chromium plate and therefore it was necessary to develop a new grinding and polishing compound.

The reflectivity of chromium is selective to about the same extent as silver. It is doubtful if the ordinary observer would be able to distinguish between the two. Therefore, the color is pleasing. The coefficient of reflection is initially high and remains high throughout an accelerated life test.

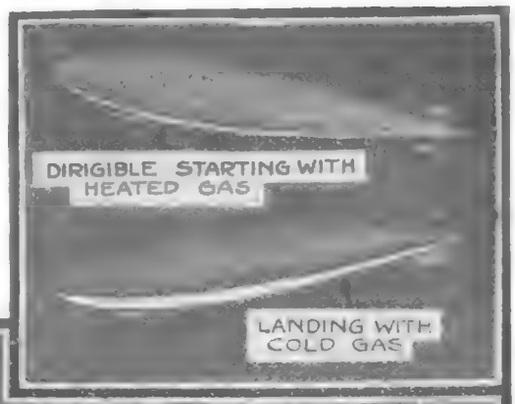
Chromium is not subject to corrosion from sulphur fumes or water vapor, the first a cause of tarnishing in silver. Chromium is only attacked by chlorine fumes which are very rare in the atmosphere.

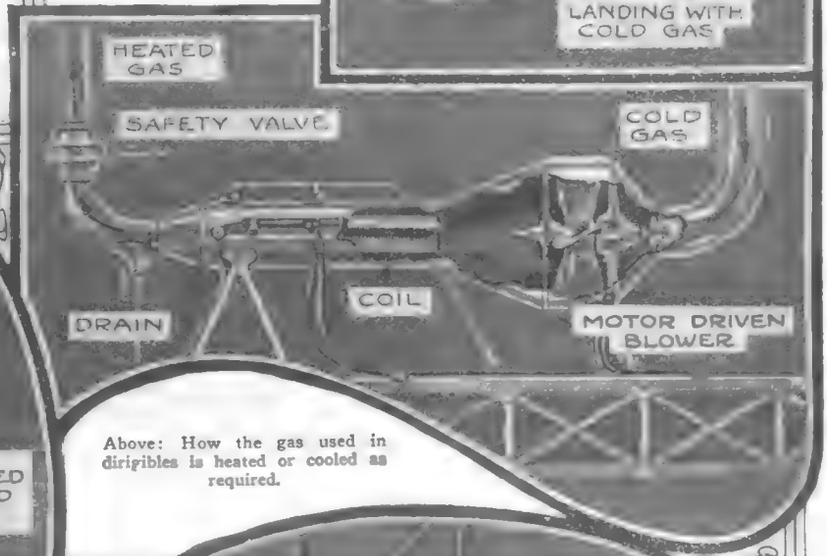
How Dirigible Gas Temperature Is Controlled



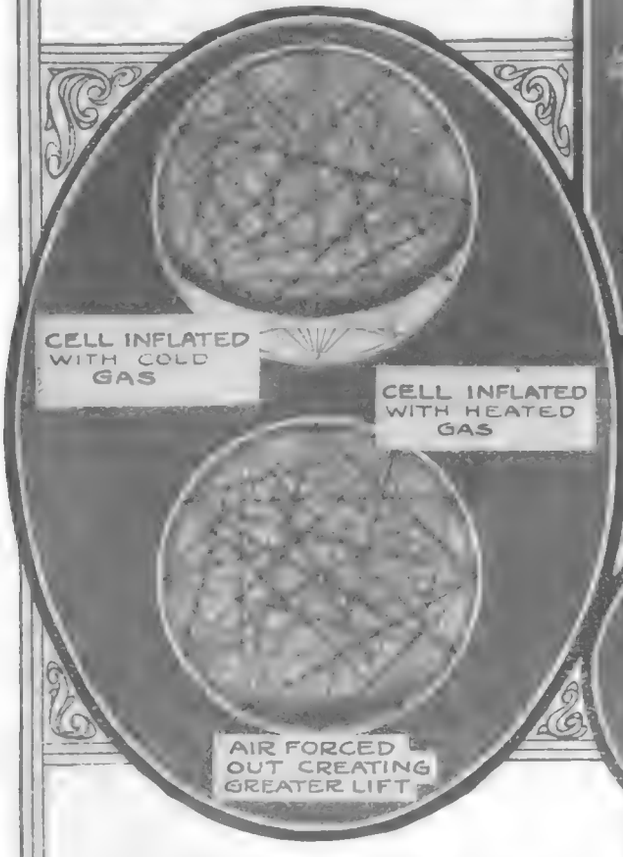
The diagrams above show comparisons between the lifting power of heated and cold gas with the approximate lift, pay-load and ballast required in each case. The right-hand diagram above shows the greater buoyancy of heated air.

In the two dirigibles illustrated at the right, the shaded portions show the gas while the unshaded parts of the bag indicate the volume of air which replaces the space left by the contracting gases as they cool. Heated gas has greater lifting power.

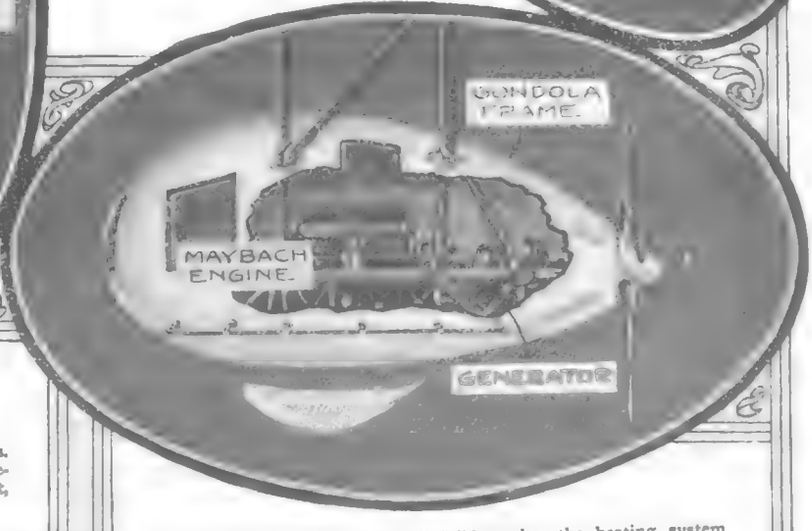




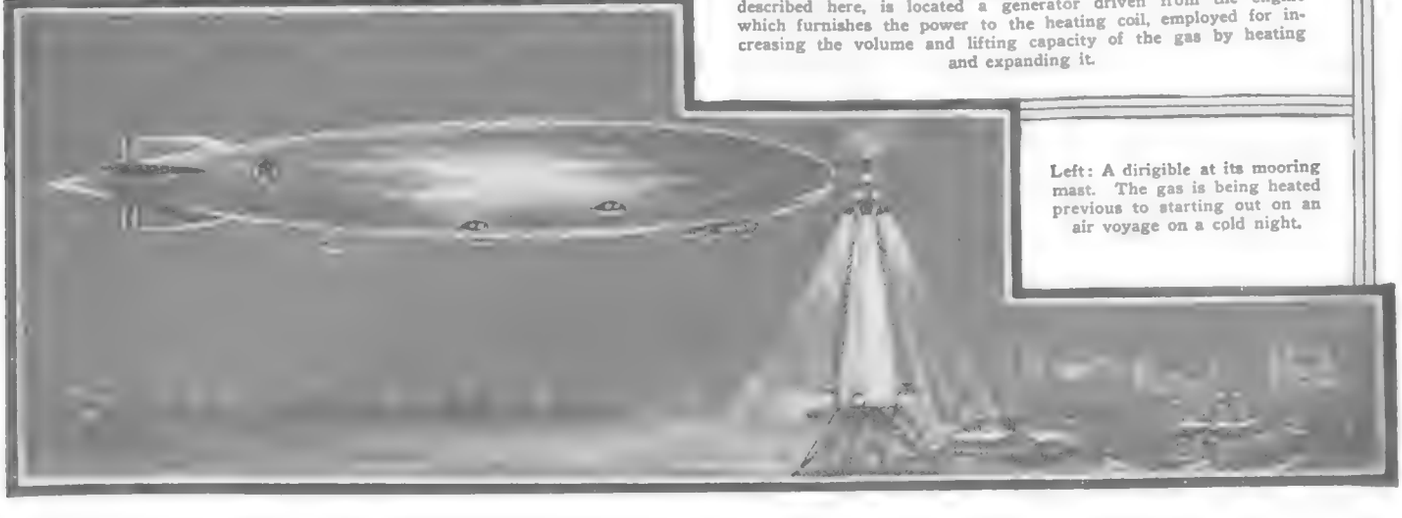
Above: How the gas used in dirigibles is heated or cooled as required.



In the above diagrams, shaded portions indicate gas. Here it is shown how greater lifting power is obtained because of the larger volume of gas created by heating it, using the device illustrated elsewhere on this page.



In the gondola of a typical dirigible, using the heating system described here, is located a generator driven from the engine which furnishes the power to the heating coil, employed for increasing the volume and lifting capacity of the gas by heating and expanding it.



Left: A dirigible at its mooring mast. The gas is being heated previous to starting out on an air voyage on a cold night.

Electrical Gas Temperature Control for Dirigibles

By WILLIAM P. SULLIVAN, Aeronautical Engineer.

A NEW and very effective device for controlling the buoyancy of dirigibles by a process of electrically heating the gases with which they are inflated, and by gradually cooling it as the load become lighter, owing to the decrease of fuel and supplies, has recently been perfected in Germany by two Berlin chemists, Dr. Kurt Peters and Peter Schlumbohm. This new device will increase the safety and control of flying dirigibles and greatly reduce the cost of operation, especially over great distances.

This means of control consists of a small electric motor-driven blower, situated just below the gas bags on a mounting fastened to the structure, which blower circulates the gas through jackets surrounding an electrically-heated coil, returning it to the gas bags or balloonets at a higher temperature. This increase in temperature causes the gas to expand to a greater volume, thereby creating a larger displacement and adding to the buoyancy or lift of the cells. The opposite means of control consists of circulating the gases through the jackets with the heating coil off and cooling it by radiation. This cooling of the gas causes it to contract in volume, which decreases its buoyancy or lift.

These units of temperature control are placed at close proximity to each other or to a series thereof, depending on the cubic feet capacity of the sections, and are operated by remote controls from the main control cabin. By this means, the buoyancy of any section of the ship can be changed by the pilot, facilitating ease of control and adding to the effectiveness of operation.

The present means of controlling the buoyancy of the dirigibles is obtained through the use of ballast and gas valving. This method, being the only one used up to date, has not only proved extremely expensive and dangerous, but has greatly reduced the pay load of the ship. The ballast necessary for safe control weighs a considerable amount, and the cost of carrying this dead load over a period of time is enormous. For instance, the ZR-3 (the *Los Angeles*) under certain conditions, with the air and gas at zero degree Centigrade, the air at a humidity of 60 degrees and the balloonets filled with the safety capacity of 2,500.000 cubic feet of hydrogen, having a specific gravity relative to air of 0.1, the total lifting effort would be 89.6 tons. The lifting effort of helium being approximately 92 per cent. of this, the gross weight of the ship equals 45.5 tons, leaving a useful lift of 44.1 tons. On long cruises, the ship is equipped to carry 17 tons of fuel and the remaining weights go into crew, supplies and the dead load of ballast.

To start on a cruise with, say 20 tons of fuel and supplies that will be in the course of the trip used up, compels a dirigible, therefore, to carry ballast as a dead load; to be used, together with the valving of the gas, which means a dead loss, for maintaining the buoyancy and control of the ship throughout the cruise.

With the new electrical temperature control of the gas, a dirigible can prepare to start a cruise by heating the gas from power supplied from a generating plant at the mooring mast, operating the blower with the heating coils while the ship's power units remain at rest. This method increases the lifting capacity of the ship at a period when the fuel and supplies are the heaviest. When the ship's motors start running and the ship has started its cruise, the power for operating the heating units is controlled from the cabin and supplied by generators coupled directly on the engine drive shafts, with the conventional wind-driven generators suspended from the cabin and nacelles, now used for heating and lighting, connected for emergency purposes.

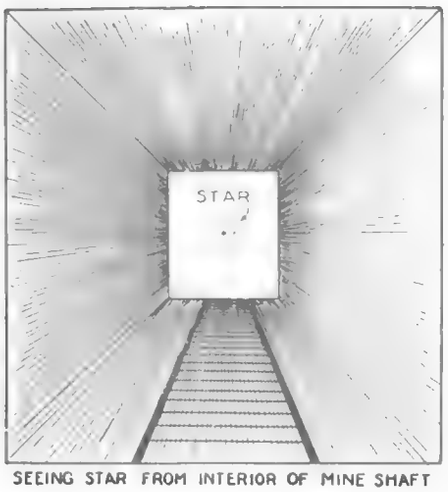
As the ship progresses on its course, the fuel and supplies begin to diminish, and to offset this, the gas is allowed to cool, decreasing in buoyancy equivalent to the weight of the exhausted fuel and supplies. This method continues under ordinary conditions until the safety limit is reached in gas temperature change, before the use of any ballast or gas-valving is called for. This represents an enormous saving of gas, which is an important factor, and facilitates a greater pay load.

During the flight, the system is used for altitude control of the ship. Upon entering a warm stratum of air, the ship can maintain its desired altitude by cooling the gas and establish the displacement necessary for level flight. The reheating of the gas can be accomplished upon entering a cold stratum of air for the same reason, or any reasonable altitude can be arrived at by either heating or cooling the gas as desired by the pilot.

In making a landing at the end of the trip, when the fuel and supplies have been reduced considerably, the present method is to valve gas to decrease the buoyancy or lift, enabling the ship to come close to the ground for attaching itself to the mooring mast or to be hauled into its hangar. If the ship should settle too quickly, ballast has to be thrown out, which case involves the element of danger. In some instances, filled fuel tanks have had to be released in order to again regain buoyancy enough to prevent crashing to earth. With the new device in operation, the gas can be allowed to cool gradually, reducing its volume and decreasing lift sufficient to offset the losses in weight of fuel and supplies, and the ship brought down, without the loss of gas, under complete control from the cabin.

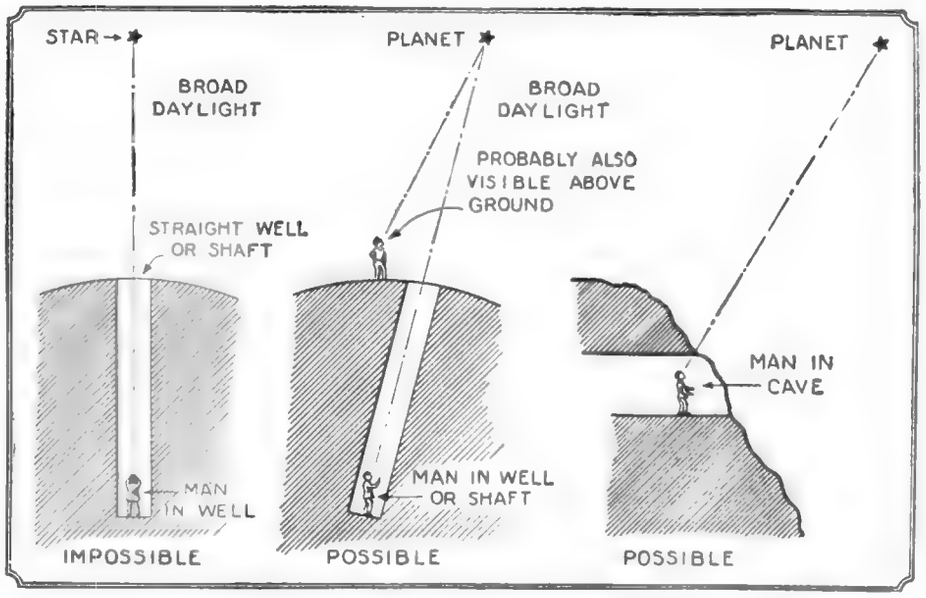
The dirigible, now having control of the temperature, can fly at any time, under any reasonable atmospheric conditions, with more safety and reliability and can be maintained in the air with considerably more economy. It must be understood that this electrical control of gas temperature is designated as a separate control to be used in addition to and similar to the regular controls, such as the use of ballast and the valving of gas. Its use is designed to enable a dirigible to increase its pay load on long trips and to add to the ship a smooth operating safety device long needed in dirigible operation.

Viewing Stars from a Deep Well



SEEING STAR FROM INTERIOR OF MINE SHAFT

There is an old belief that is quite prevalent throughout the world that stars can be seen in the daylight if the observer will descend into a mine or deep well and look upward. That such is not true has been recently pointed out by Prof. C. C. Wylie. The visibility of a star at any time depends upon its contrast with the background and this will not be changed regardless of the depth that one descends below the earth's surface.

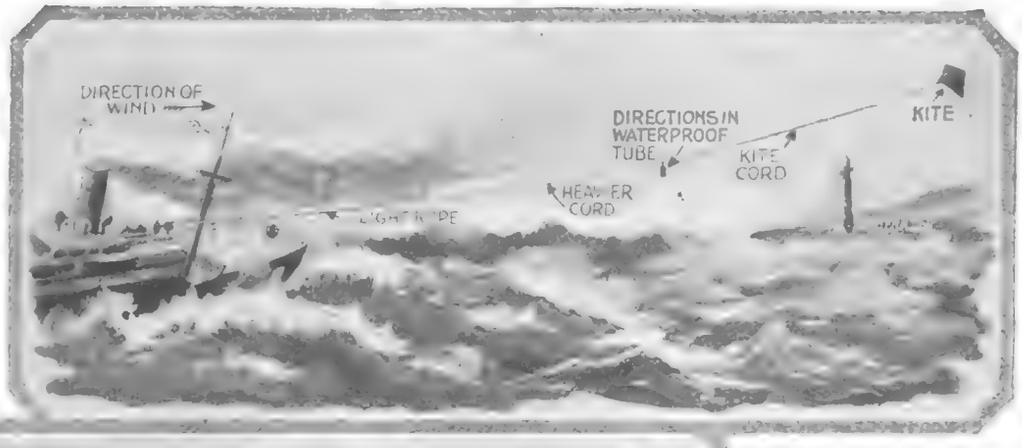


As stated at the left, it is impossible to see stars from the bottom of a deep well but sometimes it is possible to view certain bright planets in daylight when at the surface of the earth. The visibility is not increased by descendng in a well and in any case, in the United States or Europe, planets would have to be viewed from an inclined shaft or from the mouth of a cave as shown inasmuch as they never reach the zenith. —Donald H. Menzel.

Kite to Rescue Shipwrecked

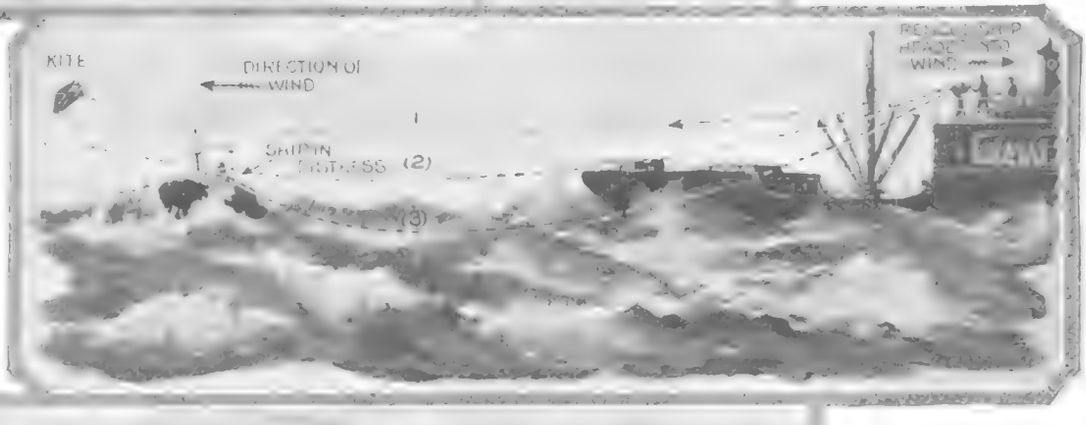
Will Carry Messages to Shore or Rope for Breeches Buoy to Ship in Distress

Right: A ship has been blown towards shore by a heavy wind and is in dire distress. Efforts to reach the ship from shore have failed. A kite, attached to a light cord is sent up and it blows in towards shore. It carries a water-proof tube containing directions for rescue and also, attached to the end of the kite-cord is a heavier one, and on the end of that is a rope. The kite, carried by the wind toward shore is held down somewhat by the heavy cord and the rope and soon the rescuers on shore can retrieve the kite, cord or rope, read the directions in the water-proof tube and eventually pull in a heavy rope upon which a breeches buoy can be operated. The passengers and crew can then be taken from the ship, rescued by the aid of a kite.



Left: There is a vessel in distress in mid-ocean. A rescue ship appears. The conventional Lyle gun for carrying a line to the disabled vessel is practically useless due to the pitching of the ships. A kite is sent up from the rescue vessel after it has worked to the windward side of the one in distress. Controlled by a manually operated brake, the flight of the kite is carefully regulated. When a certain length of cord has been utilized, a light rope starts to run out. This is followed by a heavier one as shown in the insert A.

Right: The kite carrying the light cord flies over the ship as at 1. As the heavier rope is fed out, the weight drags down the kite somewhat to the position shown at 2. As the still heavier rope is used, it sinks to the deck level of the ship in distress whereupon it is retrieved and made fast to the masthead. It is said that a rescue method of this type is effective over comparatively great distances. Two thousand feet or more can separate the vessel in distress from the rescuer.



After the line, carried by the kite has been fastened to the masthead of the disabled ship, it is fastened to a similar point on the rescue vessel and is kept taut by means of a quick acting winch so that regardless of how much either of the ships roll or toss, the rope connecting them is always tight. Along this rope, a breeches buoy can be rigged and pulled back and forth between the two ships until all of the people on board the disabled vessel have been removed to safety. This is illustrated in our artist's drawing at the immediate left.

How Kite Is Used

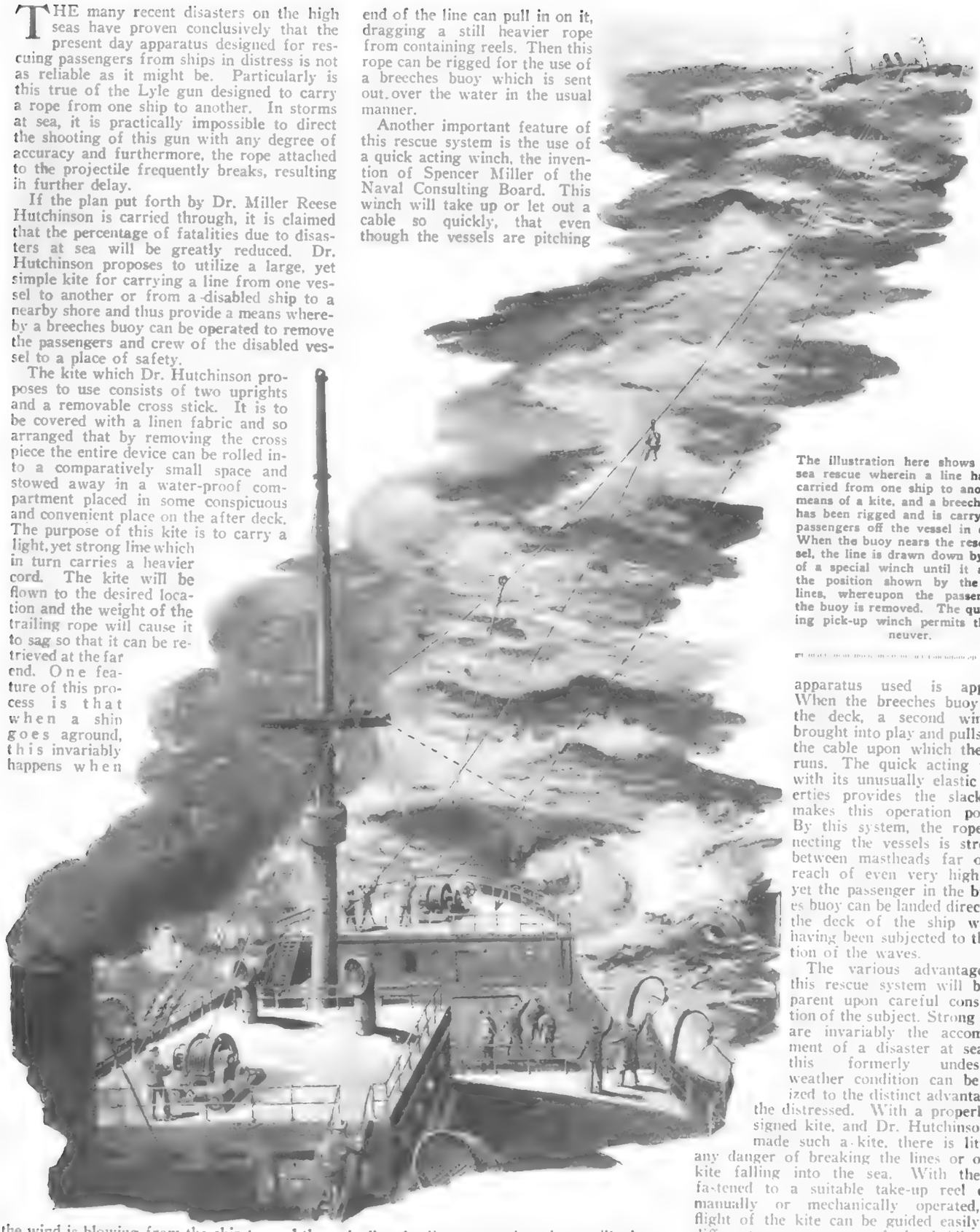
THE many recent disasters on the high seas have proven conclusively that the present day apparatus designed for rescuing passengers from ships in distress is not as reliable as it might be. Particularly is this true of the Lyle gun designed to carry a rope from one ship to another. In storms at sea, it is practically impossible to direct the shooting of this gun with any degree of accuracy and furthermore, the rope attached to the projectile frequently breaks, resulting in further delay.

If the plan put forth by Dr. Miller Reese Hutchinson is carried through, it is claimed that the percentage of fatalities due to disasters at sea will be greatly reduced. Dr. Hutchinson proposes to utilize a large, yet simple kite for carrying a line from one vessel to another or from a disabled ship to a nearby shore and thus provide a means whereby a breeches buoy can be operated to remove the passengers and crew of the disabled vessel to a place of safety.

The kite which Dr. Hutchinson proposes to use consists of two uprights and a removable cross stick. It is to be covered with a linen fabric and so arranged that by removing the cross piece the entire device can be rolled into a comparatively small space and stowed away in a water-proof compartment placed in some conspicuous and convenient place on the after deck. The purpose of this kite is to carry a light, yet strong line which in turn carries a heavier cord. The kite will be flown to the desired location and the weight of the trailing rope will cause it to sag so that it can be retrieved at the far end. One feature of this process is that when a ship goes aground, this invariably happens when the wind is blowing from the ship toward the shore and therefore, it is always possible to direct the kite to the desired shore. When disaster happens on the high seas, the rescue vessel can always be maneuvered to the windward side of the ship in distress and the kite line can be placed just where it is desired. After the line has reached the shore from the disabled ship or has been placed across the deck of the ship in distress, those at the kite end of the line can pull in on it, dragging a still heavier rope from containing reels. Then this rope can be rigged for the use of a breeches buoy which is sent out over the water in the usual manner.

Another important feature of this rescue system is the use of a quick acting winch, the invention of Spencer Miller of the Naval Consulting Board. This winch will take up or let out a cable so quickly, that even though the vessels are pitching badly, the line connecting them will always be under the same tension. Thus the danger of injuring persons being carried by the breeches buoy is entirely eliminated as are also sudden stresses and jerks on the rope itself.

The illustration on this page shows in the foreground the after deck of a rescue vessel. Persons are being removed from another ship in distress and the entire action of the apparatus used is apparent. When the breeches buoy nears the deck, a second winch is brought into play and pulls down the cable upon which the buoy runs. The quick acting winch, with its unusually elastic properties provides the slack that makes this operation possible. By this system, the rope connecting the vessels is stretched between mastheads far out of reach of even very high seas, yet the passenger in the breeches buoy can be landed directly on the deck of the ship without having been subjected to the action of the waves.



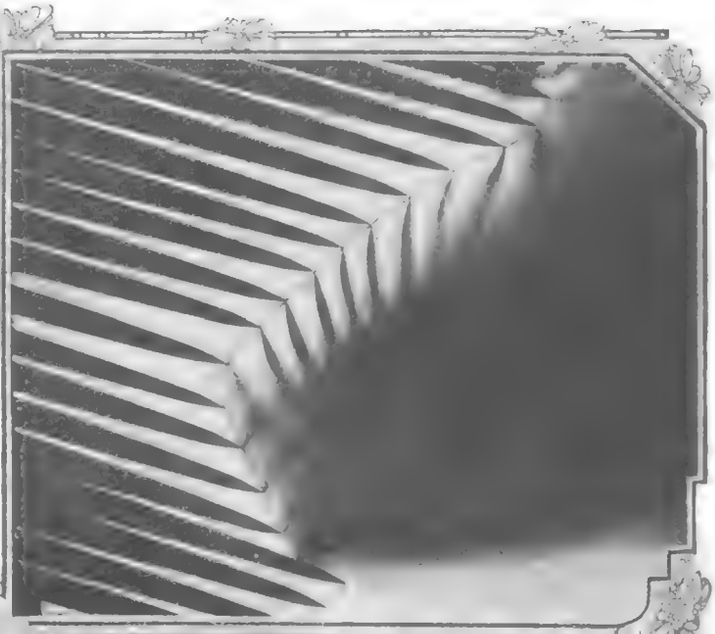
The illustration here shows a deep sea rescue wherein a line has been carried from one ship to another by means of a kite, and a breeches buoy has been rigged and is carrying the passengers off the vessel in distress. When the buoy nears the rescue vessel, the line is drawn down by means of a special winch until it assumes the position shown by the dotted lines, whereupon the passenger of the buoy is removed. The quick acting pick-up winch permits this maneuver.

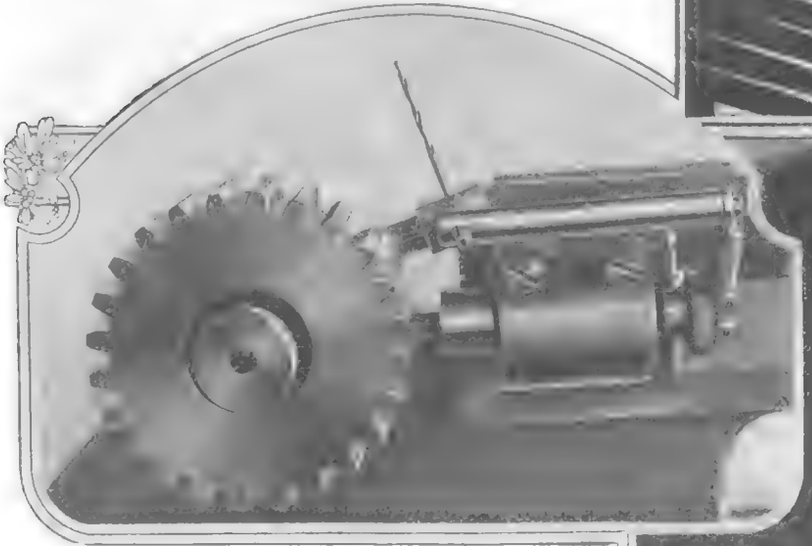
The various advantages of this rescue system will be apparent upon careful consideration of the subject. Strong winds are invariably the accompaniment of a disaster at sea and this formerly undesirable weather condition can be utilized to the distinct advantage of the distressed. With a properly designed kite, and Dr. Hutchinson has made such a kite, there is little if any danger of breaking the lines or of the kite falling into the sea. With the line fastened to a suitable take-up reel either manually or mechanically operated, the flight of the kite can be guided easily. By different arrangements of the bridles, Dr. Hutchinson's kite can be made to fly high or low as may be best for the conditions under which it is being used. It has been found possible to make one of these kites fly almost directly overhead or to soar off at great distances only a few feet above the surface. Thus, by shifting the lines, any desired result can be obtained from the kite with very little trouble.

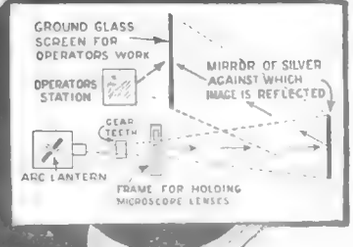
Shadows Show Gear Teeth Defects

By ALLEN P. CHILD

The operator of this new gear teeth checking device is shown above in front of the ground glass screen upon which the shadows are projected and upon which he can make sketches for checking.





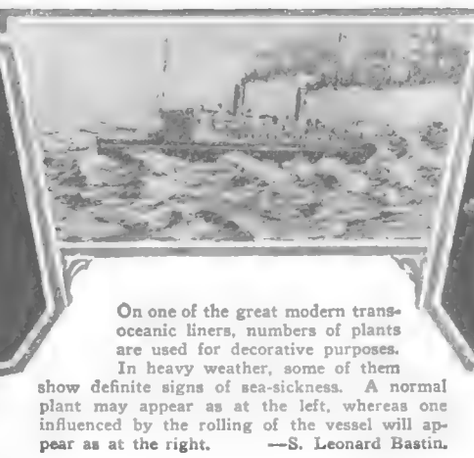

GROUND GLASS SCREEN FOR OPERATORS WORK
OPERATORS STATION
MIRROR OF SILVER AGAINST WHICH IMAGE IS REFLECTED
GEAR TEETH
ARC LANTERN
FRAME FOR HOLDING MICROSCOPE LENSES

The above photograph shows one of the machines that holds a series of needles against one tooth on a gear wheel. An arc light is projected against the teeth whereupon the shadows thus formed are magnified, reflected by a silvered mirror and projected on a ground glass screen. In the case of some gears, this projection is done without the needles, whereupon the operator sketches the outline of one tooth on a screen, moves another tooth into position and checks its shadow against that of the first tooth. It is said that discrepancies of .0001 inch can be detected.

The mirror that is used in this work is silvered on the front instead of on the back and in this way distortion is avoided. Sometimes templets are used to check teeth, whereupon the view on the ground glass appears as above.

Did You Know That Flowers Get Seasick?

Above: Flower in normal state.



On one of the great modern transoceanic liners, numbers of plants are used for decorative purposes. In heavy weather, some of them show definite signs of sea-sickness. A normal plant may appear as at the left, whereas one influenced by the rolling of the vessel will appear as at the right. —S. Leonard Bastin.

Above: Sea-sick flower.

Union Hours in Flower Land

It can readily be demonstrated in the home, that flowers can be made to adapt themselves to local conditions. The only apparatus necessary for the demonstration is a pot of marigolds and a fairly strong electric light. These marigolds open in the daytime and close at night, so that they are open approximately 12 hours and closed for the same period of time.

If the marigolds are put in a dark room and left in darkness all day and illuminated for 12 hours during the night, they will, after several days' repetition of this alteration, change their habits and will open at night and close in the daytime; being influenced solely by the light and dark periods obtained by means of the bright light and the dark room.

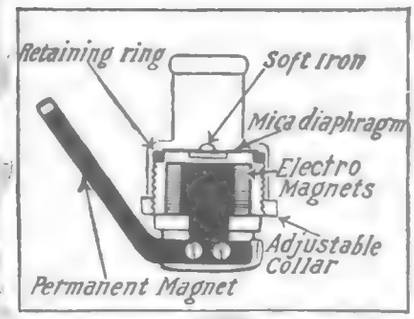
Thus we can see that the flowers are readily adaptable to environment and if we slowly shorten the successive periods of light and darkness, the flowers will follow, so that soon they can be trained to open and close every 8 hours, following the light closely. Perhaps by shortening the periods very slowly you can even get the flowers to work on a 6-hour shift.

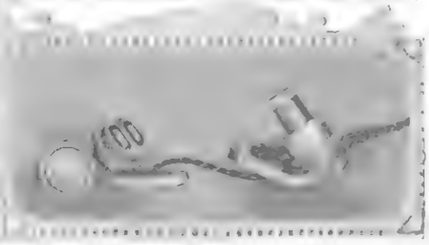
Finally you will note that when the alterations between light and darkness are made too often, the flowers will not follow. At about 4-hour periods they will get disgusted and quit and the peculiar thing is that they will go back to the original 12-hour shift and pay no attention to the artificial changes, until the periods are lengthened.—Dr. Russell G. Harris.

Receivers That Fit the Ears

THOSE who, due to difficulty in hearing, operate radio receiving sets requiring the use of headphones, usually find that the wearing of these phones becomes quite a burden, after having used them for several hours at a stretch. Particularly is this true in warm weather, when excessive perspiration at the ears is present, caused by the phones covering them. Then too, if the phones are very heavy, they are an unpleasant weight on the head, and unless the headband is properly adjusted, the receivers are liable to press against the ears causing distress. The tiny receiver that is illustrated at the right has recently been designed and placed on the market and is said to overcome practically all of the difficulties found with standard size phones. These new midget reproducers are said to be quite efficient and to give faithful tonal qualities to all sounds. They are so light in weight and small in size, that they can be placed directly in the outer ear channel, and they will stay there without any retaining band or clamp of any kind. One of our illustrations shows these receivers in use and how they are placed in the ears. The other pictures show the various essential parts. Standard receiver design practice has been followed in miniature.

These small phones are made with a double pole electro-magnet and utilize a mica diaphragm with a soft iron armature. In this way, the best possible reproduction of sound is obtained with the least distortion.





Above: The details of this new miniature receiver. The retaining ring is of soft rubber and the clearance between the soft iron armature and the pole-pieces is adjustable by means of the collar shown. These phones can be furnished in both [illegible] and low resistances for different types of [illegible] photograph at the left above shows actual use, being employed in con radio receiving set.

Motion in Window Display

GRAY PAPER
SCENE PAINTED ON GLASS
MICA CYLINDER WITH LINE DESIGNS ON IT
AIR TURBINE
REVOLVING CYLINDER
WARM AIR CURRENTS RISING THRU TURBINE ROTATE IT.

Left: This scene shows a fisherman pulling a fish from an apparently flowing stream, the motion effect being obtained by lights.

The falling snow and fire effect in the above illustration is obtained by two cylinders revolving back of the semi-transparent parts of the picture, and arranged as shown in the small photo at the left.

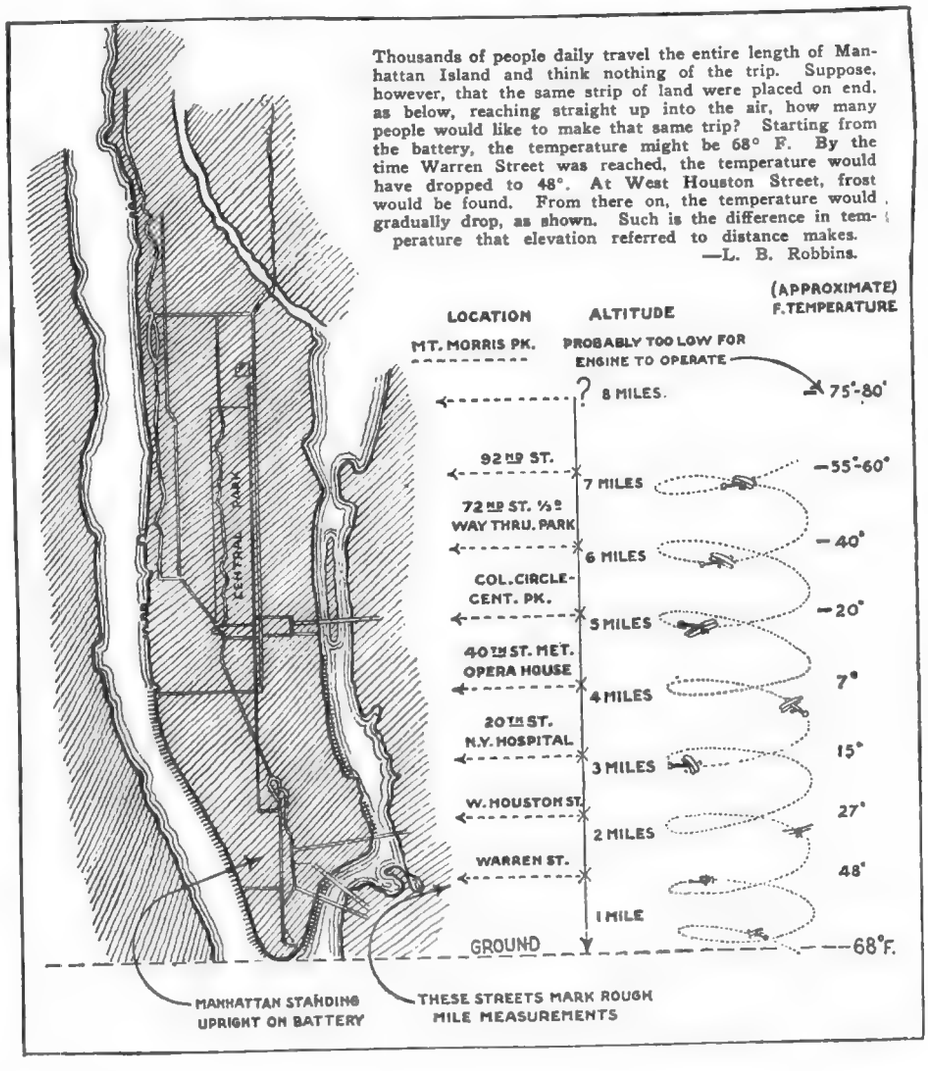
Above and left: Details showing how motion effects are produced. Painted cylinders revolve, due to air rising from incandescent bulbs, and produce scenic effects.

Attractive window displays and decorative pictures for the home are now available, in which motion plays a prominent part. Sections of the illustrations are semi-transparent and behind these sections revolving painted cylinders are in action. By using various combinations of colors and lines, falling snow, forest fires, flowing streams and other picturesque features of the scenes can be produced. Our illustrations above show some of them, and also indicate how the results are produced. The lights from the rear are diffused by the gray paper shown. —Felix J. Koch.

The Latest Style in Mooring Masts

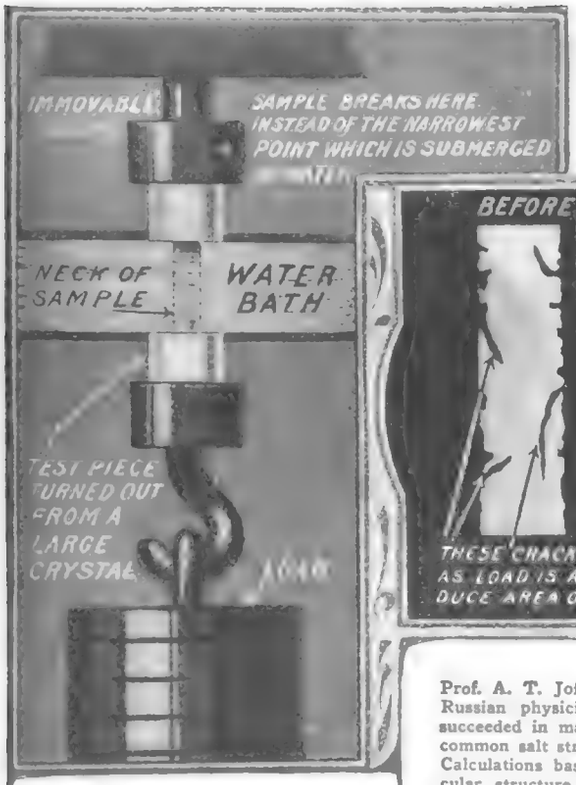
Travel by air is becoming so prevalent today that in even out-of-the-way corners of the earth, we find provisions made for handling aircraft of all descriptions. The photograph above shows the dirigible mooring mast at Ewa, Hawaii. It was built according to the latest ideas in the construction of "hitching posts" for lighter-than-air craft. Note the rigidity of construction which is ensured by numerous, judiciously-placed guy wires.
—Leo A. J. de Roo, Rep. No. 26732.

If New York Were Stood on End

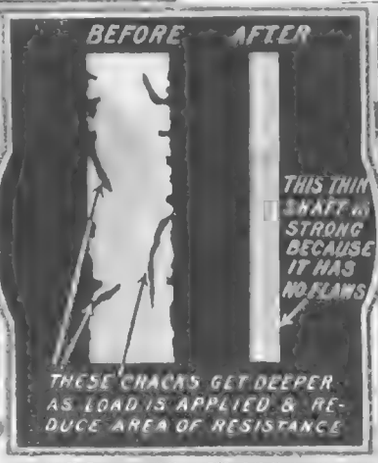


Thousands of people daily travel the entire length of Manhattan Island and think nothing of the trip. Suppose, however, that the same strip of land were placed on end, as below, reaching straight up into the air, how many people would like to make that same trip? Starting from the battery, the temperature might be 68° F. By the time Warren Street was reached, the temperature would have dropped to 48°. At West Houston Street, frost would be found. From there on, the temperature would gradually drop, as shown. Such is the difference in temperature that elevation referred to distance makes.
—L. B. Robbins.

Salt Stronger Than Steel

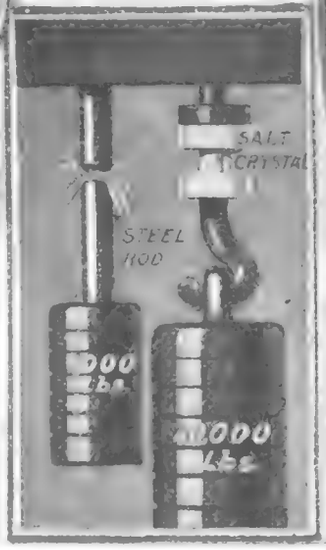

IMMOVABLE
SAMPLE BREAKS HERE INSTEAD OF THE NARROWEST POINT WHICH IS SUBMERGED
NECK OF SAMPLE
WATER BATH
TEST PIECE TURNED OUT FROM A LARGE CRYSTAL

As above, the parts of the test piece that have the flaws in them will break before the thinner but flawless part. However, if the flawless part is allowed to dry, it also develops cracks and becomes weak.


BEFORE
AFTER
THIS THIN SHAFT IS STRONG BECAUSE IT HAS NO FLAWS
THESE CRACKS GET DEEPER AS LOAD IS APPLIED & REDUCE AREA OF RESISTANCE

Prof. A. T. Joffe, a well-known Russian physicist, has recently succeeded in making crystals of common salt stronger than steel. Calculations based on the molecular structure of salt crystals show that the normal tensile strength should be about 300 kilograms per square mm. Prof. Joffe found that this could be increased 20 times by closing or filling the exterior flaws as above.

As illustrated at the left, the reason that a shaft of salt is weak is because of the minute flaws which can be closed by action of water. The sample is then much stronger although it is thinner.



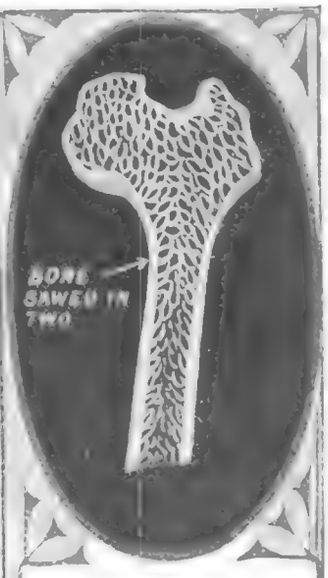
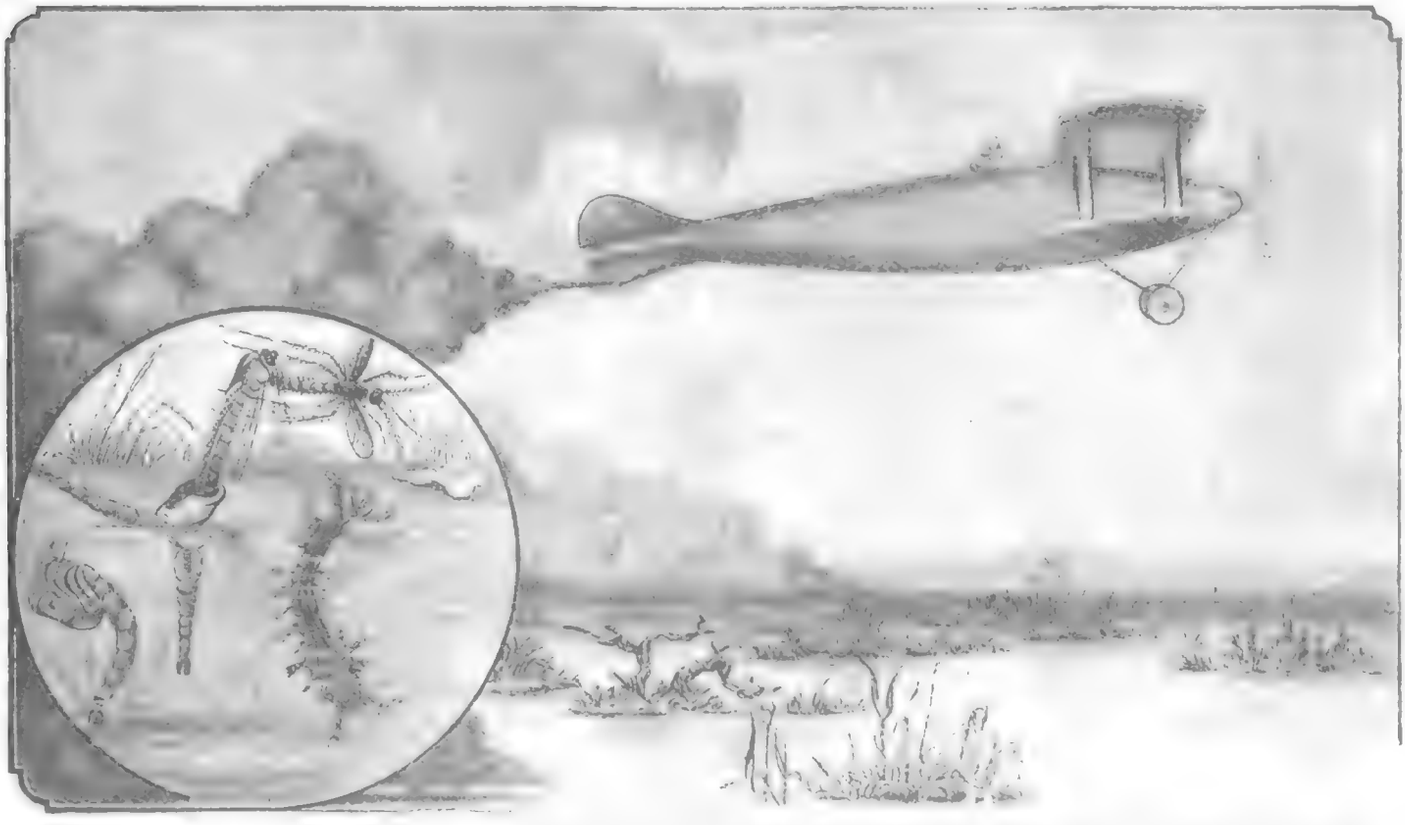


Illustration at left shows strength of treated salt crystal before it has dried out. Bony structures, as above, are very strong, due to overlapping parts.

—Leon J. Israilevich, Reporter No. 17905.

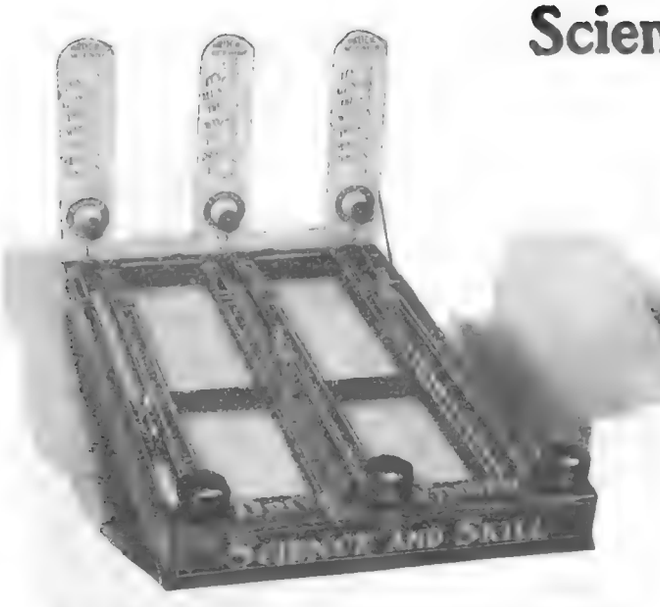
Airplanes Fight Mosquitoes



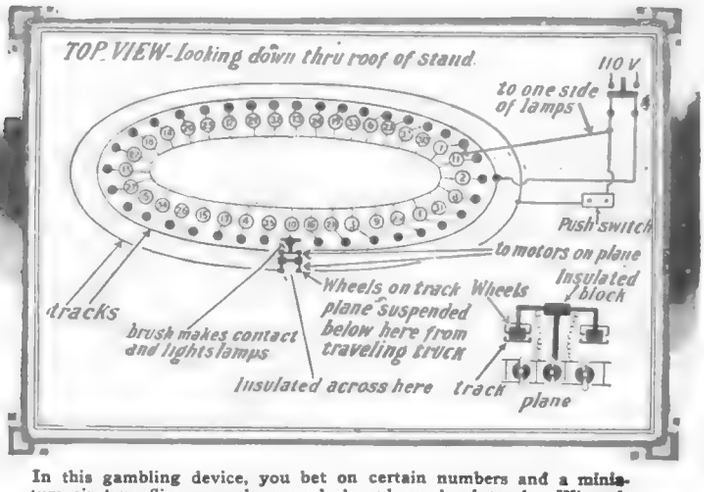
Airplanes can now be pressed into service to exterminate mosquitoes and their larvae. The work is accomplished by distributing over breeding places of these pests a cloud of dust that is poisonous to insects but harmless to men and animals. This method is far superior to the present tedious one of spreading oil over the surfaces of mosquito infested ponds, particularly as regards time required. Plantations dust crops with planes.

Science in Games of Chance

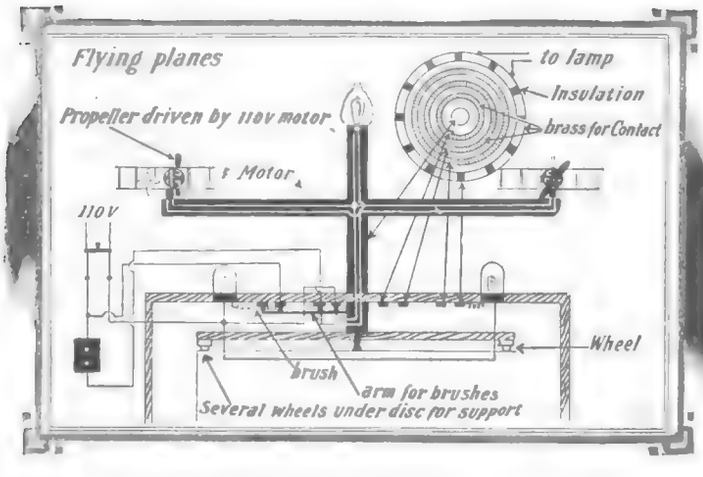
By GEORGE HOLMES



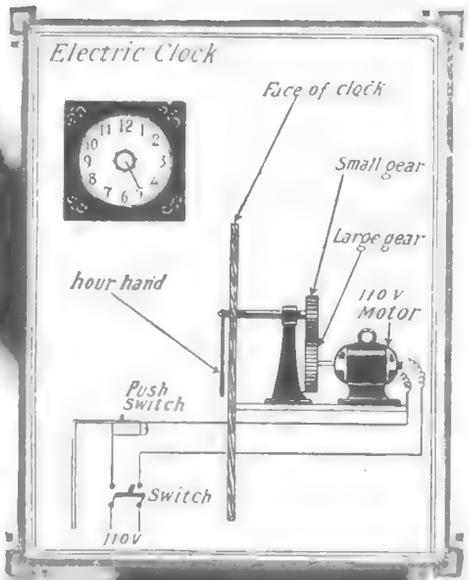
In the above device, three competitors tap the knobs with their hands. The horses run up the grooves and, according to how the operator sets the device, one of them wins.



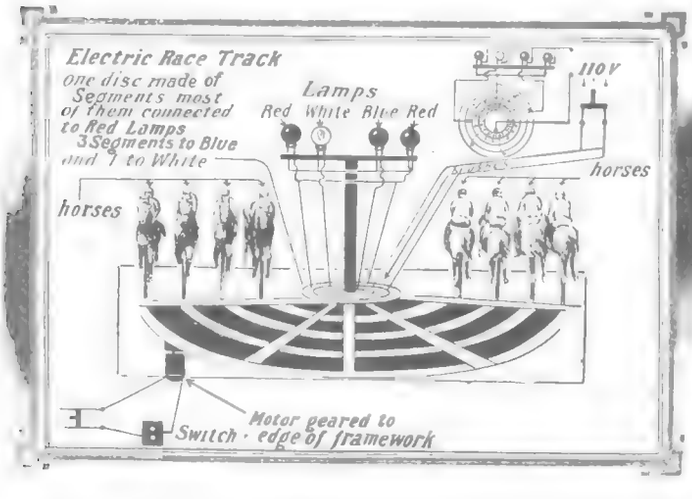
In this gambling device, you bet on certain numbers and a miniature airplane flies around an oval shaped overhead track. When it finally comes to a stop, the number that it indicates wins.



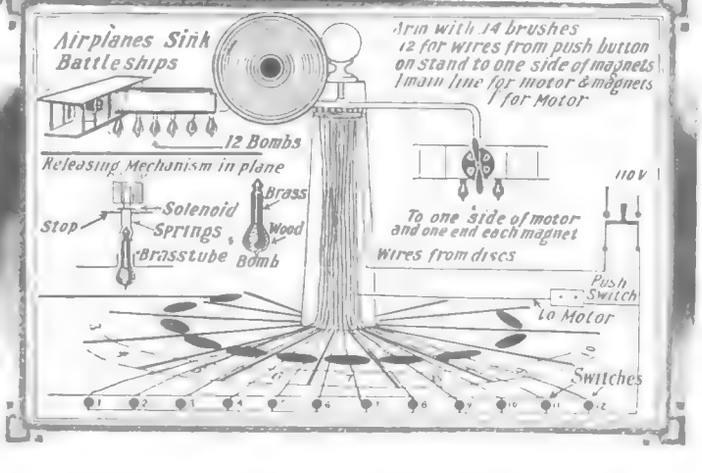
Another device that employs miniature airplanes in its operation is illustrated in detail above. The planes are mounted on arms and revolve continuously until the power is cut off. When the device coasts to a stop, the light that remains illuminated indicates the number that wins



The electric clock is a new and compact novelty now used at fairs and carnivals for enticing the money of the public into the pockets of the stand-owner. Here, as in the usual game, the participants bet on numbers. The operator closes the switch that actuates the electric motor and the single clock hand spins around. After a certain length of time the switch is opened and the hand allowed to come to a stop. The number that it indicates is the winner. Most of the devices illustrated on this page are perfectly legitimate, but they can easily be made "crooked."


Electric Race Track
one disc made of Segments most of them connected to Red Lamps
3 Segments to Blue and 1 to White
Lamps
Red White Blue Red
110V
horses
horses
Motor geared to Switch edge of framework

Here is another horse racing device that attracts quite a little attention. The horses race around a cylindrical track in grooves, being operated by an electric motor concealed under the table. When the circuit is opened, one of the lights in the center cluster remains illuminated, indicating the winner of that particular race.



This is a rather interesting little proposition in which the players attempt to make the bombs from the airplane hit the spots representing ships on the baseboard. They release the bombs by pressing one or another of the switches shown. When a hit is made, the bomb sticks in the place where it lands, indicating a number that may win a prize.

The Human Side of Ants

By PAUL GRISWOLD HOWES

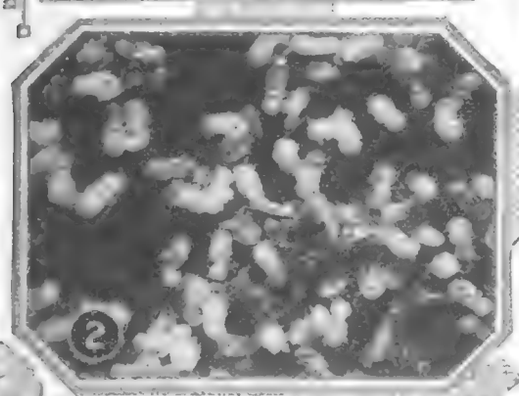
Curator Natural History, Bruce Museum, Greenwich, Conn.

Ants will completely strip a carcass of flesh in a few hours. Note ant on skull.

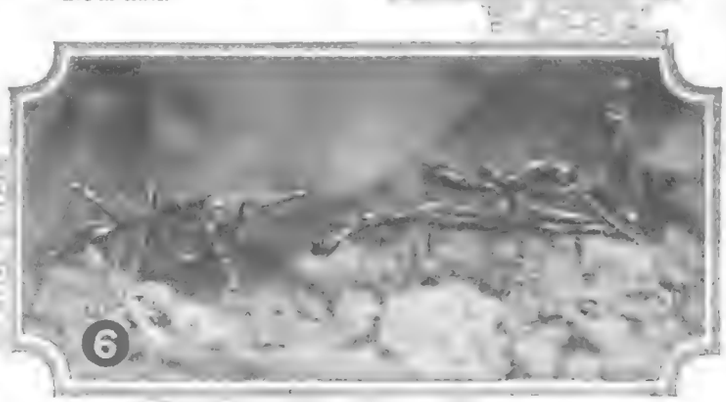
Photo 2 illustrates an ant nursery. This consists of a hollowed space beneath a flat, sun-warmed stone. The young ants are brought up from subterranean galleries to be benefited by the warmth.

Ant's battles, at 3, are serious affairs involving entire colonies. The individuals fight until their adversaries are torn to bits. Note the mangled bodies in the photograph.

Ant dairymen, at 4. The little bugs at the top of the photo are known as plant lice, or "ants' cows." Ants have learned to obtain sweet droplets from these tiny bugs by gently stroking them. They herd their cows tenderly.



Ants are of special interest to man because of their social habits and their ability to live in cities.



The photo, 5, here shows ants as highway robbers. An ant carrying something particularly valuable is waylaid and robbed by two others. Note the bulldog attitude of the robber ant.

Bringing home the bacon—6. The ants have been on a foraging party. The worker in the lead is carrying another insect victim's leg to the nest, while the warrior follows as a guard. (Photos by the author.)

OF ALL the orders of insects, that one known scientifically as the Hymenoptera, which includes the ants, bees, wasps and saw-flies, is, doubtless, of greatest interest to man. The creatures that fall into this order are most highly organized, and while some lower creatures may simulate their social life, probably no other living insects have reached the perfection in community life and in the division of labor, as have the ants. Their ability to live successfully in great cities, under a single ruler, or queen, in a state of perfect organization and contentment, has long caused man to delight in studying their ways, and I now wish to add my drop to the bucket of ant lore, in the form of first-hand photographs of their wonderful doings, which show, in a remarkable way, the very human side of these little insects.

ANTS AS MEAT PACKERS

As in our own big world, so in that smaller one of the ants, the meat packer is of primary importance in the ant city. In the tropics especially, ant colonies are much more ferocious and blood-thirsty than in the north, and I have seen them completely strip a carcass of its flesh in an hour's time. These bits of flesh, removed by the individual ants, are quickly dried in the warm atmosphere and carried to the nests, where they are packed away for future use. The skeleton in the photograph was assembled by the author from the bones stripped by these meat-packer ants in South America. Mounted upon the bird's skull is a single ant for comparison. From this it is not difficult to imagine how many packer-ants were employed in the job of cleaning up the pigeon whose skeleton is shown.

NURSERIES

The nurseries of the ant colony are of great interest. These may be deep in the ground or in the black recesses of a great hollow tree. They are also frequently beneath a flat stone, which is thin enough to become gently warmed by the sun. Under such stones, baby ants, which, at first, resemble tiny maggots, are tenderly fed by the old ones upon specially prepared food, while those in a later stage of development may be warmed in the nursery during the daytime, as shown in the picture. Close inspection of an ant nursery will reveal all the tender care that one sees a human nurse or mother lavish upon her charges.

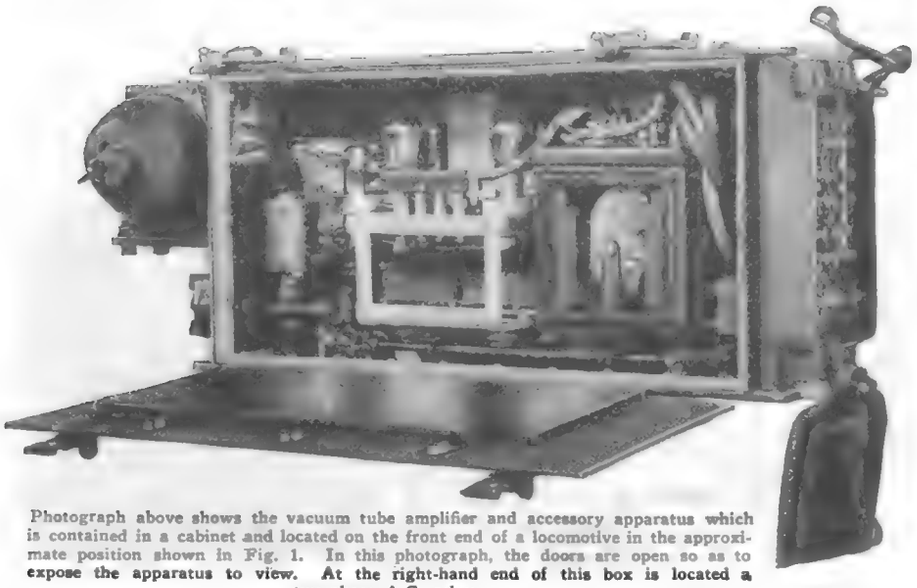
One of the most human traits of ants is fighting. Their battles are very serious affairs, often involving entire colonies, and individual warriors fight until their adversaries are literally torn to bits.

MANY KILLED IN BATTLE

Our big, black, carpenter ant, with which everyone is familiar, is particularly given to battling, and the place where such combats

(*Continued on page* 86)

Automatic Train Stop Perfected



Photograph above shows the vacuum tube amplifier and accessory apparatus which is contained in a cabinet and located on the front end of a locomotive in the approximate position shown in Fig. 1. In this photograph, the doors are open so as to expose the apparatus to view. At the right-hand end of this box is located a two-phase A.C. relay.

The above photograph was taken in the cab of a locomotive and shows the electrically illuminated signal box placed in full view of the engineer. On this box, the letters H and L will be discerned.

A GREAT many disastrous railroad accidents have been caused by engineers running past signals, due either to low visibility or personal neglect on the part of the man at the throttle. For years, hundreds of engineers have been working on the problem of providing electrical control for trains that will eliminate the human element, and its well-known fallabilities, and thus make railroading far safer than it is today. One of the best of these systems is illustrated on this page and has been placed in practical use on the double track, main line of the New York, New Haven and Hartford railroad between New Haven, Conn., and Springfield, Mass. The system is the type known as the Continuous Inductive System and to date has proved most satisfactory in operation.

The inductive effect noticeable in A. C. circuits has been utilized in the design of this control system, in which the rails carry an alternating current. This current of course sets up a magnetic field around the

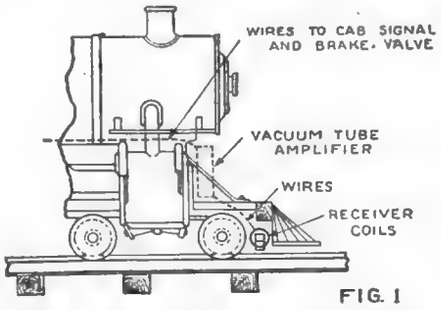


Fig. 1 above shows the location of the vacuum tube amplifier on a steam-driven locomotive.

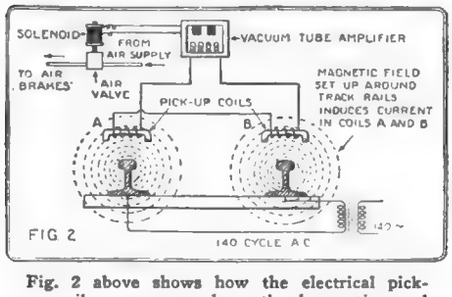


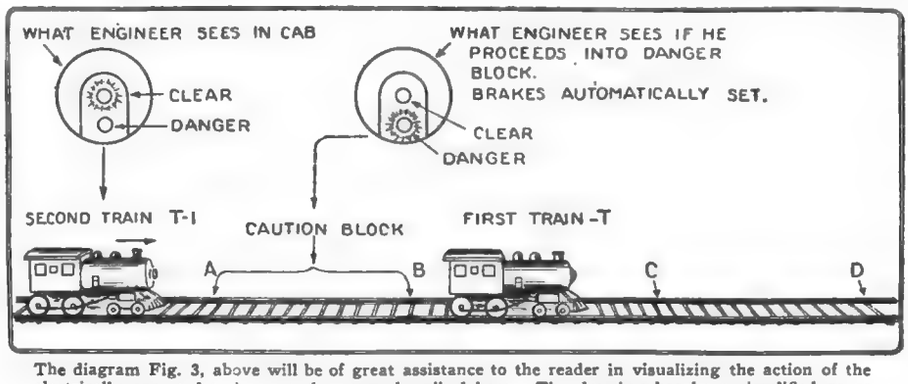
Fig. 2 above shows how the electrical pick-up coils are arranged on the locomotive and connected to the vacuum tube amplifier and electrical brake control.

rails as indicated in Fig. 2 and a current is induced in coils A. and B. This current being of a frequency of 140 cycles, does not interfere with the driving motor current used on electrical railroads, which is 25 cycles; or with the block signal system which uses 60 cycle current. This is accomplished by means of carefully tuned filters, which will pass only the frequency of the current that is to actuate the stop control.

After the current picked up by the coils is fed into the vacuum tube amplifier, the resulting output is connected to the train control relay, which actuates the air brakes of the entire train. The relay is a modified two-phase motor.

In addition to the 140 cycle current mentioned above, the 60 cycle current used for the signals is also employed to operate track relays and to close and open circuits as trains pass through the various blocks. This current is carried by the rails but does not affect the apparatus on the locomotive, because of the difference in frequency.

By referring to the diagram here showing the sections of track and two trains T and T1, the action of the entire system can be explained as follows. Train T occupies the block of track BC, at one end of which a 60 cycle current is applied to the two rails. At the other end of the block is a 60 cycle track relay which will not respond to either 25 or 140 cycle current. This source of current and a corresponding track relay is applied to every section of the railroad. Now it is obvious that when a train is in the block, the wheels and axles will form a low resistance path between the rails and the relay connected to the far end of the block will be short circuited and deprived of current and its contacts will open. This operation in turn controls the 140 cycle current, breaking that circuit for the particular block in which the train is located. If now, a train following train T, and indicated by T1 in our drawing, approaches point A, a 140 cycle current will be flowing through the rails and the axles of train T1. It will energize the train control relay and illuminate the "clear" signal on the indicator in the cab. When, however, the train passes point A, it is necessary to slow it down, as it is getting close to an occupied block. There is no 140 cycle current in the block AB due to the operation of the track relay by train T and, therefore, there is no current furnished to the vacuum tube amplifier or the solenoid control, shown in Fig. 2, and the air brakes are applied, stopping the train before a collision can occur.



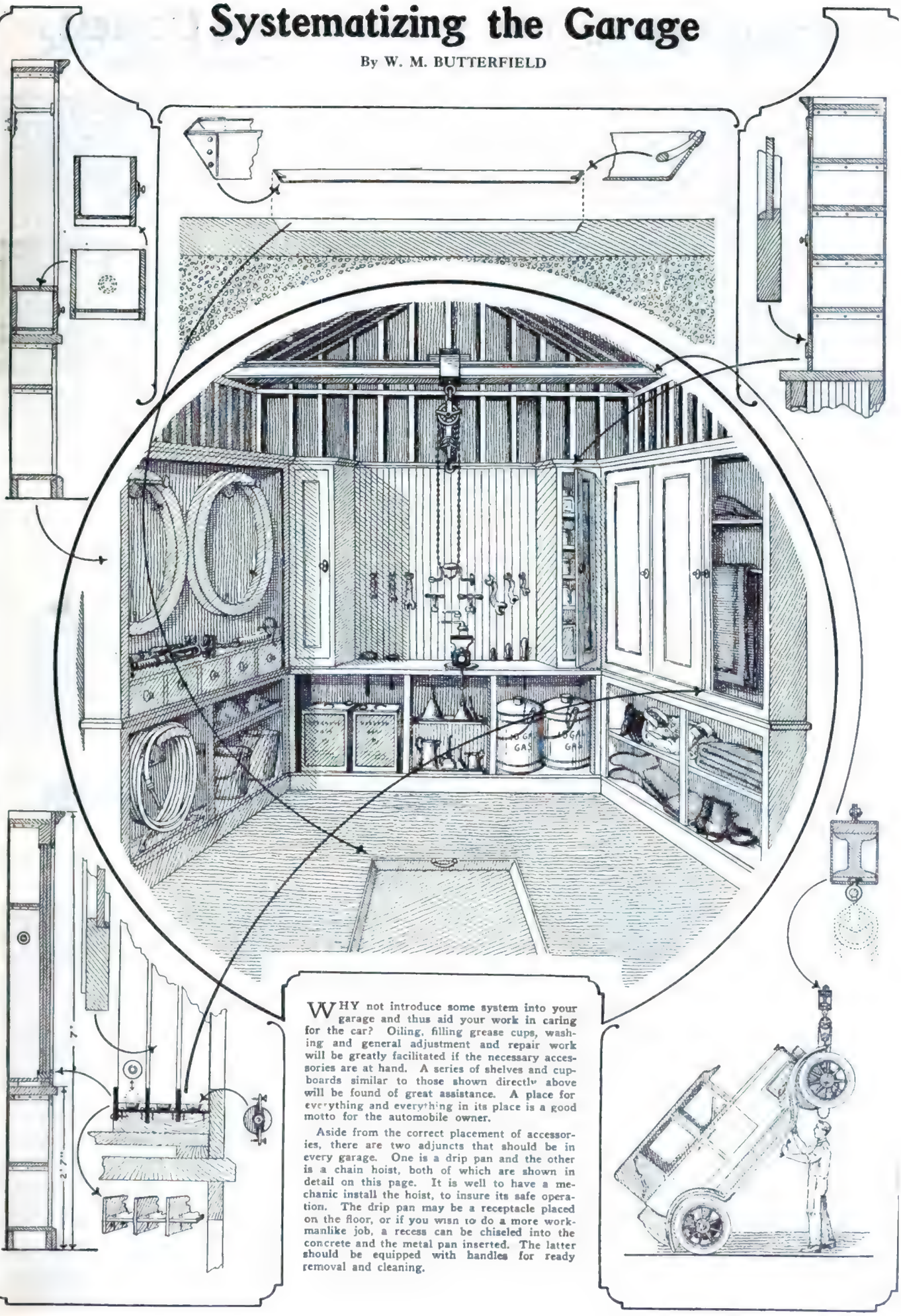
The diagram Fig. 3, above will be of great assistance to the reader in visualizing the action of the electrically operated train control system described here. The drawing has been simplified so as to show four blocks of the tracks.

The engineer can control this automatic setting of the brakes by slowing down before such a procedure becomes necessary but if he does not do so, the automatic system takes complete control of the train out of his hands and brings it to a stop long before a dangerous point is reached. The brakes are released by the engineer when he gets the "clear" signal. The brakes are applied with the steam throttle wide open, little advantage having been found in cutting off the steam, strange as this may seem.

Installations of this nature are great steps in the direction of safety.

Systematizing the Garage

By W. M. BUTTERFIELD

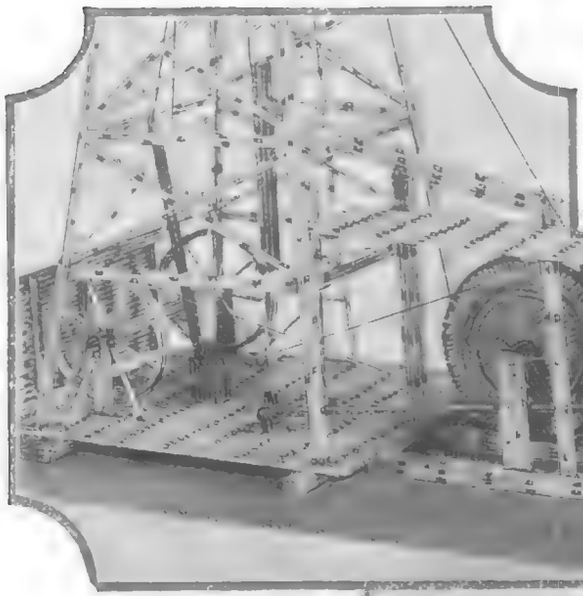


WHY not introduce some system into your garage and thus aid your work in caring for the car? Oiling, filling grease cups, washing and general adjustment and repair work will be greatly facilitated if the necessary accessories are at hand. A series of shelves and cupboards similar to those shown directly above will be found of great assistance. A place for everything and everything in its place is a good motto for the automobile owner.

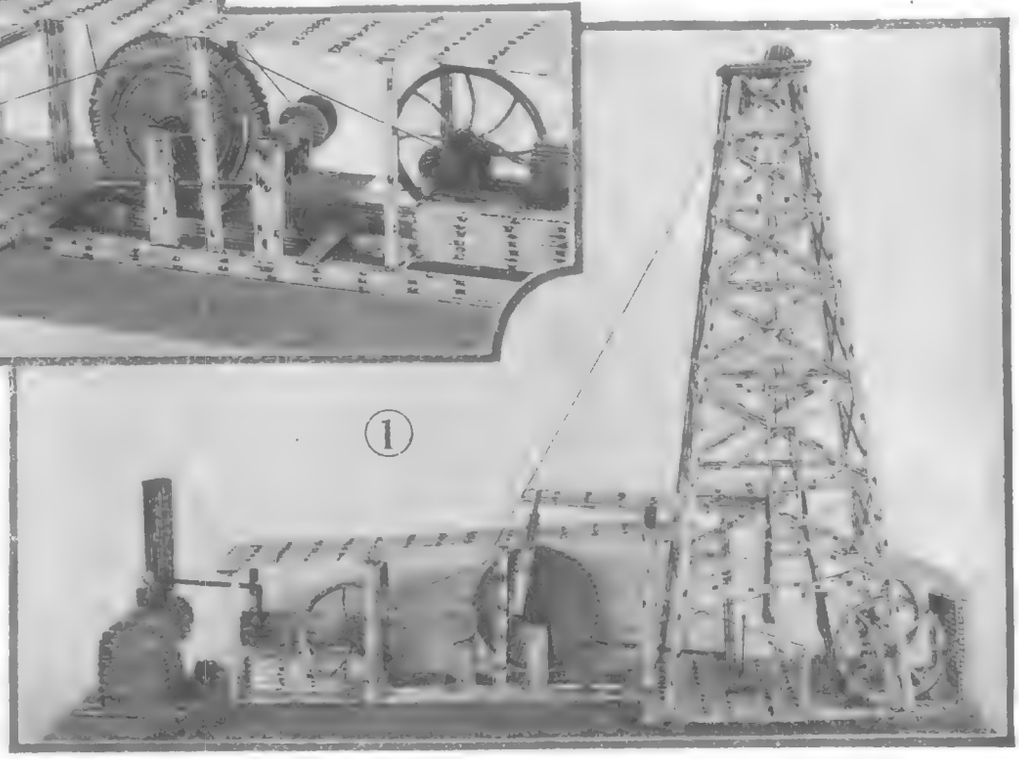
Aside from the correct placement of accessories, there are two adjuncts that should be in every garage. One is a drip pan and the other is a chain hoist, both of which are shown in detail on this page. It is well to have a mechanic install the hoist, to insure its safe operation. The drip pan may be a receptacle placed on the floor, or if you wish to do a more workmanlike job, a recess can be chiseled into the concrete and the metal pan inserted. The latter should be equipped with handles for ready removal and cleaning.

Awards In $5,000.00 Matchcraft Contest

First Prize—$100.00. Oklahoma Pumping Station Wins First Honors



IN this month's matchcraft contest the model of an Oklahoma pumping station illustrated in the two photos here shown carried away the first prize award of $100.00. This model was made by Mr. Ray C. Davis, of Detroit, Mich. The model is complete in detail and the beauty of it is that it works. With the exception of a small piece of silk and the cords acting as belts, and also as the cables for the hoist, the model is made entirely of matches. The shafts and bearings are likewise made up of glued matches. Notice from the photo immediately to the left the unique construction of the wheels acting as pulleys. In some of them the spokes are perfectly straight, but when it comes to the engine care has been taken to bend each and every individual spoke on the fly wheel.



IN the photo at the right the small upright handle located in approximately the center of the tower, serves to force a drum against the large center wheel for hoisting the drill. A rope leads from the drill to the top of the tower passing over a wooden pulley there located. This pulley is also composed of matches. Just in back of the ladder another lever will be seen which tightens upon a band brake encircling the wheel there shown. This model arrived in perfect condition in spite of the fact that the baseboard upon which the model was mounted was merely screwed to the bottom of the box. Care should be taken in the packing of a model and excelsior not forced around it.

$5,000.00 Prize "Matchcraft" Contest

WATCH FOR PRIZES IN MAY ISSUE

FOR the next ten months, SCIENCE AND INVENTION magazine will award a total of $5,000 in prizes, in a new contest. You are asked to make models, fashioning the same entirely from safety matches. Please observe the following simple rules:

(1) Models submitted must contain at least 90 per cent. safety matches in their construction.

(2) Models made of toothpicks, paper matches, or non-safety matches, are not eligible in this contest.

(3) Models can not be built around boxes or other supporting articles. Walls, roofs, etc., must all be self-supporting and made of matches.

(4) All liquid adhesives, such as glue, shellac, cements, etc., are permissible.
Water Glass makes a good glue and may be used to coat the model giving it a glasslike appearance.

(5) Models may be painted, gilded or silvered.

(6) Models may be of any size.

(7) In order to win a prize, it is necessary that either models be submitted, or, if this is not practical, owing to their size, a 5"x7" photograph of the model may be sent in lieu of the model itself. The best models submitted each month will be awarded the prizes scheduled herewith.

16 Monthly Prizes

First Prize	$100.00
Second Prize	75.00
Third Prize	50.00
Fourth Prize	35.00
Fifth Prize	25.00
Sixth Prize	20.00
Seventh Prize	15.00
Eighth Prize	12.50
9th to 16th Prizes of $10.00 each	$80.00

(8) All models submitted to SCIENCE AND INVENTION Magazine will be promptly returned to the builder, who will prepay all charges.

(9) Where SCIENCE AND INVENTION has any doubts as to the model (where photos only are submitted) complying with all the regulations, the judges may, at their discretion, request that the actual model be sent in for inspection, paying transportation charges both ways.

(10) This is a monthly contest, lasting for twelve months, each monthly contest closing on the first of the month following date of issue. This contest for the month of May will close June 1, 1926, and prize winning announcements will be made in the August, 1926, issue. The June issue will contain March prize winning entries.

(11) Models must be shipped in a strong wooden box, never in a cardboard box, as SCIENCE AND INVENTION can not be held responsible for breakage in transit due to models having been improperly packed.

(12) When models are sent, be sure to affix tag, giving your name and address, to the model itself. In addition, put name and address on outside wrapper of package.

(13) Address all letters, packages, etc., to Editor, "Matchcraft" Contest, care SCIENCE AND INVENTION Magazine, 53 Park Place, New York.

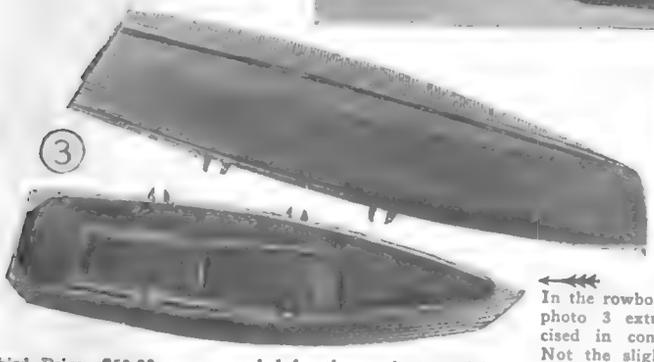
Caution—Soak or cut heads from matches before building your model so that the models may be expressed or mailed.

This contest started Dec. 1, 1925, and will terminate Dec. 1, 1926.

REMEMBER—This is a monthly contest offering sixteen prizes every month. Don't hesitate, send in your model now!

Second Prize—$75.00

THE Spanish War galleon illustrated in photo 2 was made by Mrs. V. De Schepper of Astoria, L. I., who should certainly be complimented for her splendid work and her extreme patience in setting together the 10,500 matches necessary for the construction of this galleon. As we illustrated in our last issue, "The Evening World," a New York newspaper, conducted a Matchcraft Contest in conjunction with SCIENCE AND INVENTION Magazine. Their prize winners were to be entered in this magazine's international contest. Mrs. De Schepper's unique construction won for her a second prize of $50.00 in "The Evening World" Contest, and the judges also awarded her a second prize in SCIENCE AND INVENTION Magazine's contest. Notice in the model of the ship illustrated at the right that the guns, ladders on the deck, masts and yard arms are all composed of match wood. It seems as though the young men and women in New York City have more patience and show a greater skill in the construction of match models than those located elsewhere in these United States. More models were received in the SCIENCE AND INVENTION Magazine's contest from the immediate vicinity of New York than from the rest of the country. For the benefit of those readers residing in China and Japan, the judges wish to advise that their safety matches may be used in the construction of any of the models to be submitted in this contest. The matches can be used or they may be new and if you care to save up your old matches, you may cut off the burnt portions and construct your model from the remaining pieces of matches.

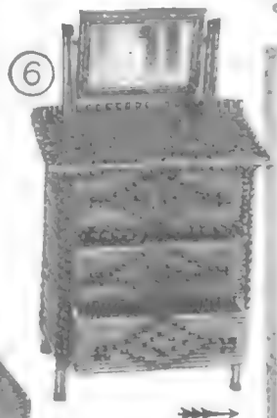


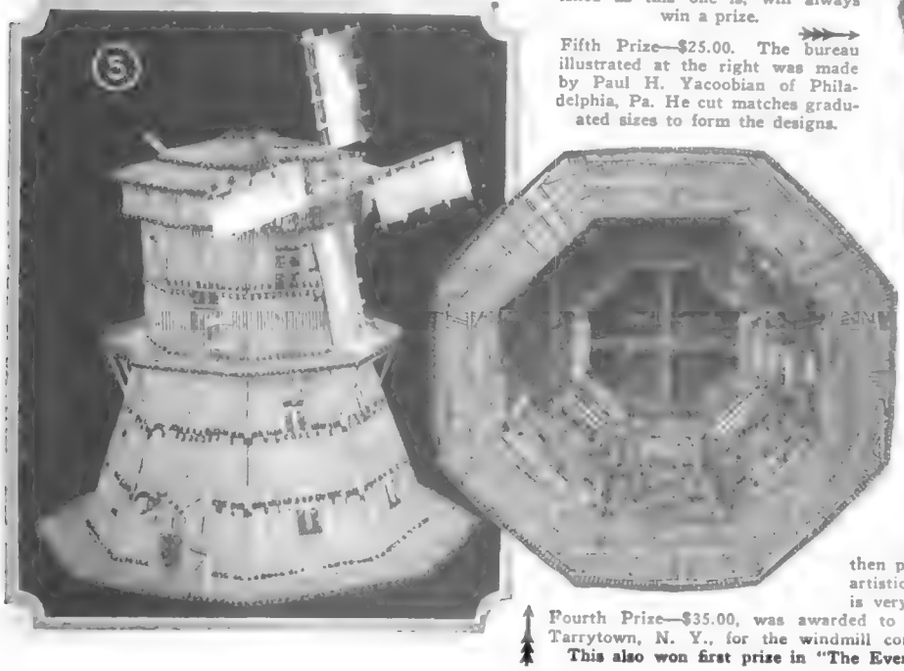
Third Prize—$50.00, was awarded for the rowboat model made by John George Christ of Bayonne, N. J.

Sixth Prize—$20.00. The beautiful scale model of a locomotive here illustrated was made by Richard O. Saxton of Detroit, Mich. The coal in the tender is of match heads. Everything in the model is constructed of matches, even including the bell.

In the rowboat model illustrated in photo 3 extreme care was exercised in constructing the model. Not the slightest detail has been omitted and the finish is superb. Cleverly constructed models finished as this one is, will always win a prize.

Fifth Prize—$25.00. The bureau illustrated at the right was made by Paul H. Yacoobian of Philadelphia, Pa. He cut matches graduated sizes to form the designs.





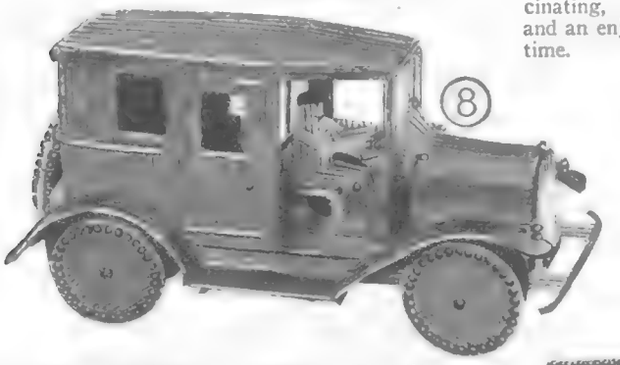
Seventh Prize—$15.00. The flowers and vase illustrated in photo 7 were made by Miss Louise Krug of Brooklyn, N. Y. Miss Krug also won the sixth prize in The "Evening World" contest. She used a special glue of her own to set the matches together and then painted the whole model artistically. The construction is very unique.

Fourth Prize—$35.00, was awarded to Arnold Wildenberg of Tarrytown, N. Y., for the windmill construction shown here. **This also won first prize in "The Evening World" contest.**

MATCHCRAFT

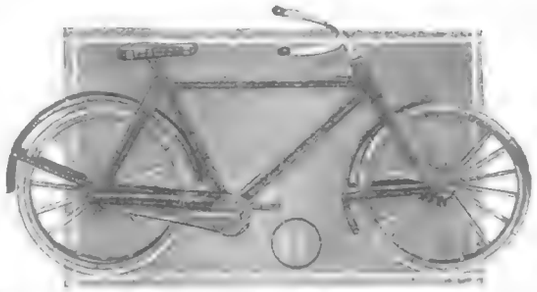
Continuing the Prize Winners For The Contest Closing March 1st. The April Contest Closes May 1st, and the May Contest Closes June 1st

MANY requests have come to the editors of this magazine concerning the technique of matchcraft. The only technique that is really necessary is the ability to exercise enough care and to have the necessary patience to construct the models. You may use any glue that you care to use in your construction. You may paint your model if you desire, although we prefer to have models unpainted because photographs of unpainted models generally appear to better effect. If models are carefully made it will not be necessary to paint, although one cannot always imply that painted models are so carelessly constructed that the paint is necessary to cover the defects. It is suggested that those who have not as yet won prizes in this contest start this very fascinating work. It is a remunerative, fascinating, instructive and an enjoyable pastime.

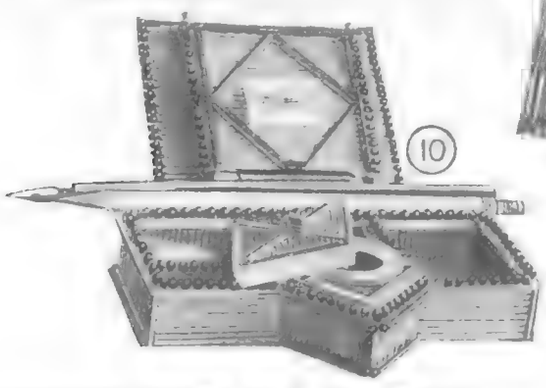


Thirteenth Prize—$10.00 was awarded to Fred Fischer of Maspeth, L. I., for his unique construction of a taxicab. The heads of matches form the tires; the door swings on match hinges and the model is complete in every detail. A rubber band imparts motion to the model.

Tenth Prize—$10.00. Mr. Jack Guischard of Ridgewood, N. J., built the house shown in photo 9. Jack is about fourteen years old and the house represents a model of the home in which he is living. Careful examination would show the presence of a rain gutter and a rain spout. The house itself is equipped with doors but not yet with the windows and floors which Jack intends to add to the construction at some early future date.



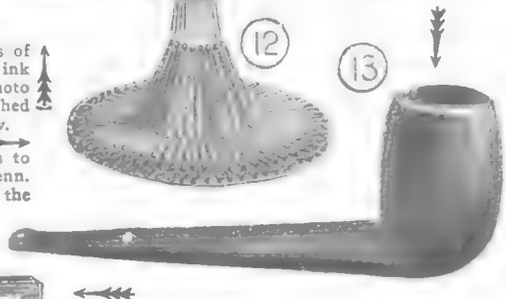
Ninth Prize—$10.00 was won by Carl Fichtner of Philadelphia, Pa., for the bicycle illustrated in photo 11. The wheels turn and the front fork turns just as in a regular bicycle. One of Mr. Fichtners previous models was smashed in shipping. This model arrived in perfect condition.

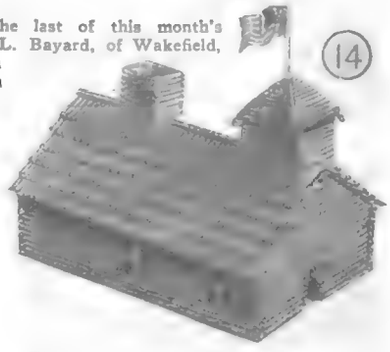


Twelfth Prize—$10.00 was won by Joseph Rosales of Brooklyn, N. Y., who constructed the ingenious ink stand and pen rack combination illustrated in photo 10. When the cover to which the calendar is attached is lifted, a memorandum pad is brought to view.

Eleventh Prize—$10.00 was awarded by the judges to the lamp made by Mrs. Eva Jurau of Pittsburgh, Penn. The shade is lined with orange colored silk and the matches painted gold and black.

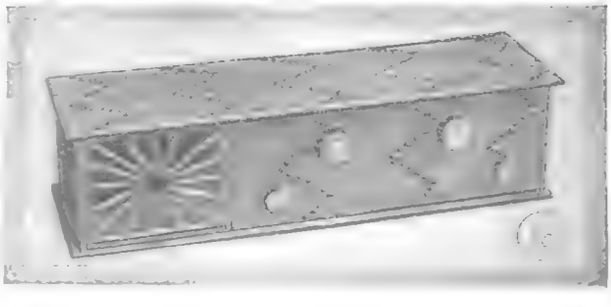
Sixteenth Prize—$10.00. The last of this month's prizes was won by Mr. E. L. Bayard, of Wakefield, Mass., for the construction of the pipe illustrated in photo 13.





Fifteenth Prize—$10.00 was the value placed upon the little red school house illustrated in photo 14. The award goes to Charles W. Reese of Zanesville, O.

Eighth Prize—$12.50 was won by Mr. George A. Wade of Brooklyn, N. Y. Mr. Wade constructed the vase shown in photo 15. The model is self-supporting and surprisingly strong when one considers that but one layer of matches has been used in the construction of the vase proper. The handles of the vase are made of several layers of matches staggered and glued together and then shaved as illustrated. The device is very symmetrical and was first entered in The Evening World contest where it won fourth prize and subsequently entered in SCIENCE AND INVENTION Magazine's contest.

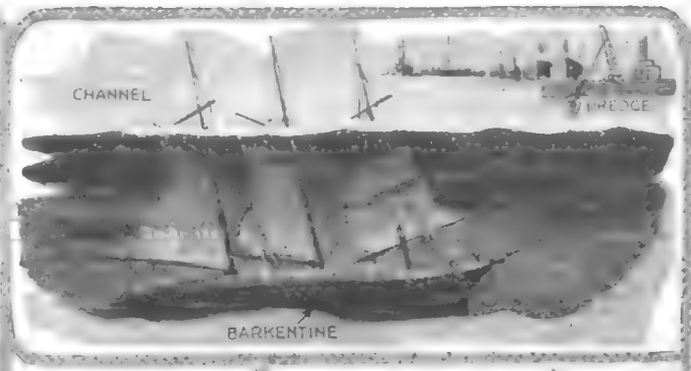


Fourteenth Prize—$10.00. Here again care has been exercised in the placing of matches so that their heads form a pattern. This miniature radio set and loud speaker was built by Willard Stadermann, of Eleroy, Ill. Careful observation will show the pattern on the cover extending down the panel of the set.

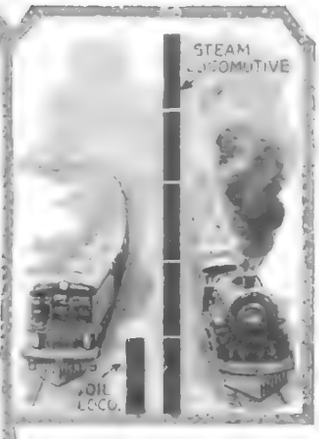
The Month's Scientific News Illustrated

By GEORGE WALL

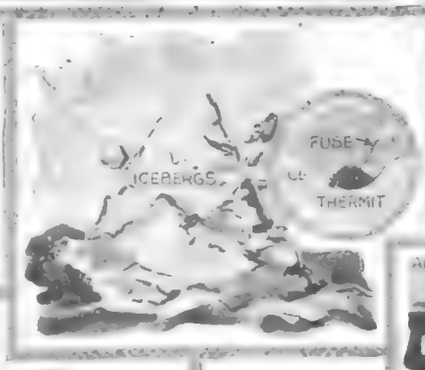
An ingenious anti-prohibitionist provided the above illustrated method of disposing of his stock in the event of a raid. Creosote destroyed odors.



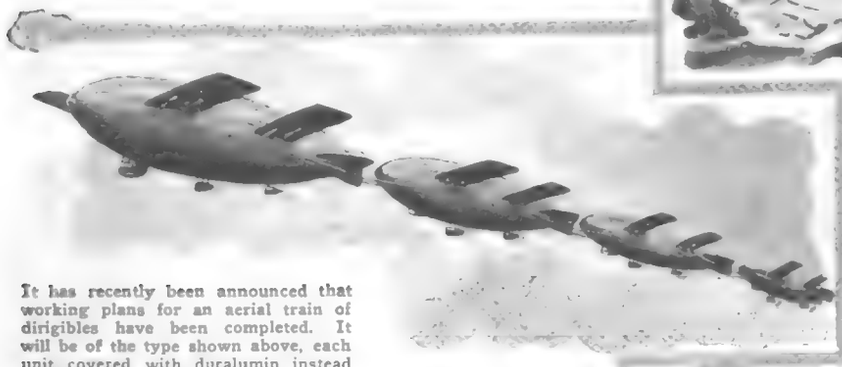
The port at Miami, Fla., was recently completely closed by the sinking of a sailing vessel directly across the mouth of the harbor. If it cannot be raised, the masts will be cut to provide room for vessels to pass.



A newly designed type of oil — electric locomotive costs approximately one-fifth as much to operate as a standard steam locomotive.



It is planned to utilize the intense heat developed by thermit in order to blast icebergs. The essentials of thermit are innocuous and easily transported.



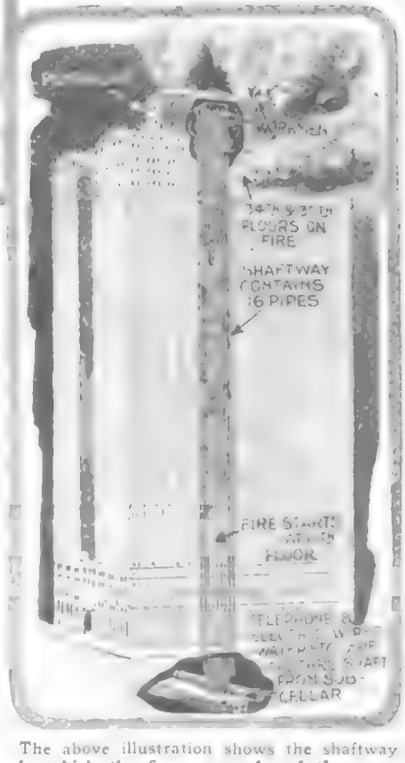
It has recently been announced that working plans for an aerial train of dirigibles have been completed. It will be of the type shown above, each unit covered with duralumin instead of fabric.

A newly designed pay-car for paying off workmen will absolutely foil bandits. Time checks and pay envelopes are passed through a slot in the side of a guarded armored car.

An engineer's yawn delayed a trans-Atlantic steamship two hours. The yawn caused a double dislocation of the jaw which had to be reset before he could leave.

A diver, working 55 feet below the surface of the water recently slipped into a hole in the top of a sunken vessel, upon which he was working, and became so entangled that he could not signal to the surface. In the emergency, he opened his air control valve, filled his diver suit with 60 pounds of compressed air and the buoyancy shot him up to the surface, propelling him into the air as shown.

In France, you can now take a vacation while supposedly on a business trip and still fool your wife into believing that you are at a distant point. A "Fool Your Wife Agency" undertakes to send her telegrams and prepared letters from various points as illustrated above. A nominal charge is made for the service.



A fire in the Equitable Building in New York City, starting 11 floors above the street recently trapped a number of men in a penthouse on the roof. The Fire Department had to fight this fire from various vantage points along the shaft. This shaftway, to which the fire was confined carries the wires and pipes supplying the building with telephone, electric light and water service.

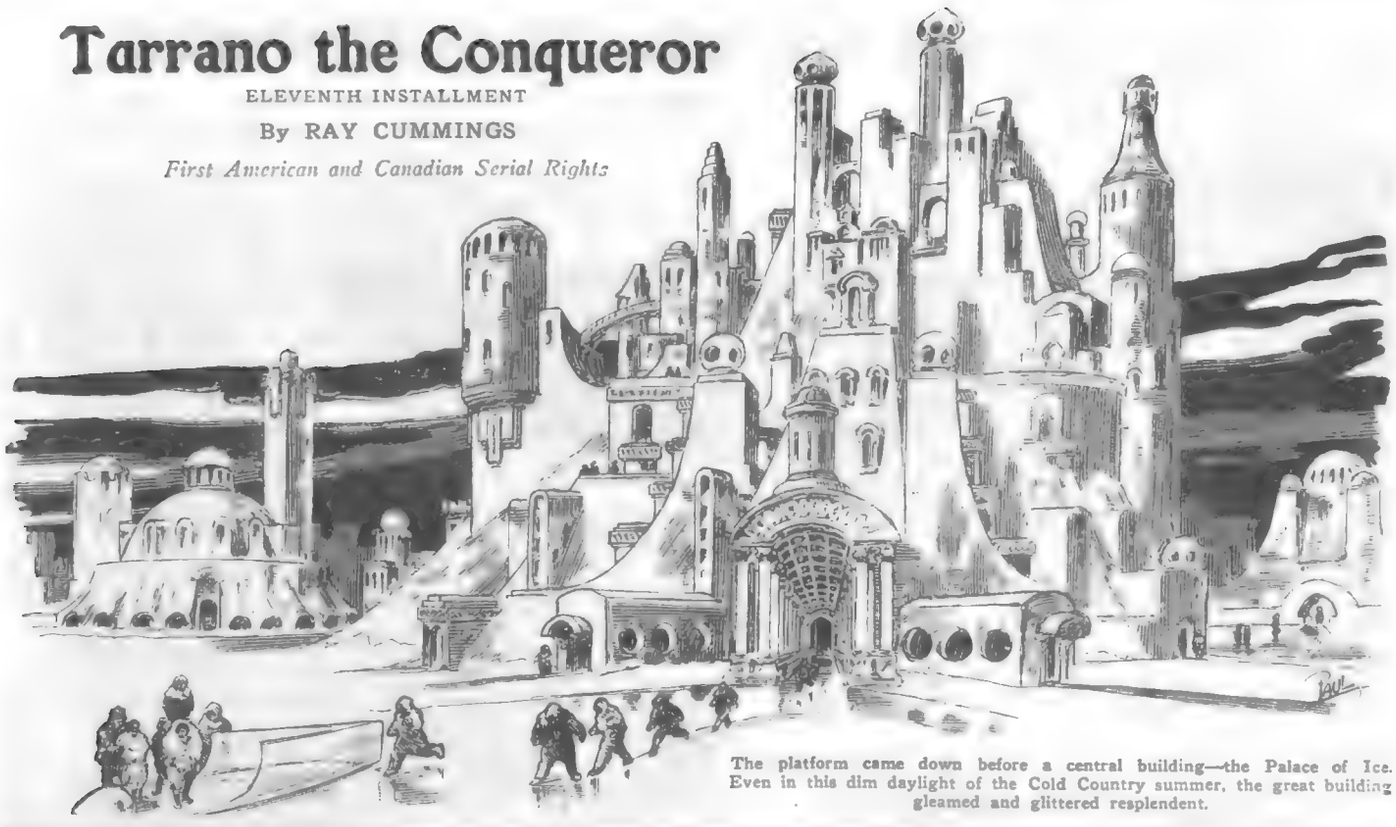
The above illustration shows the shaftway in which the fire occurred and the penthouse on the roof where the men were trapped.

Tarrano the Conqueror

ELEVENTH INSTALLMENT

By RAY CUMMINGS

First American and Canadian Serial Rights



The platform came down before a central building—the Palace of Ice. Even in this dim daylight of the Cold Country summer, the great building gleamed and glittered resplendent.

SYNOPSIS

IN the spring of the year 2325, all of the rulers of the various countries of the earth are mysteriously murdered. Jac and Grayson, employees of a large news organization, find that the murders are the result of a plot on the part of the inhabitants of Venus. Tarrano, an erstwhile lower official of the Cold Country of Venus is found to be at the head of a plot to rule the universe.

Dr. Brende, a friend of Jac's, has discovered a medical method whereby human beings may be kept from growing old. The Doctor is killed by a group of "Venus-Men" and Jac, Elza, the Doctor's daughter and Georg, the Doctor's son, are captured and taken to Venia, a city on the earth inhabited by people of Venus. Here they are imprisoned and Wolfgar, a Venus-man, friendly to the people of the earth, surrounds them by an electrical isolation barrage in an attempt to rescue them. The barrage is broken down and in the resulting confusion, Georg escapes to Washington in company with Princess Maida of Venus.

The next day, Tarrano offers to return the papers and models of the invention made by Georg's father, which he has confiscated and brands young Brende as an impostor. To offset this accusation, Georg is to tell his story to the earth as well as to Venus and Mars by radio and helio. He and Princess Maida go to the station but there they disappear.

Jac, Wolfgar and Elza, still captives, are removed from their prison and taken to the top of an enormous tower. Here, in the instrument room, where communication with the various planets is held, they view the disappearance of the Princess Maida and Georg by television. The abduction has been done by Tarrano's agents. On Mars, Tarrano's followers are attacking the ruling class and Tarrano offers Dr. Brende's secret to the public if they will surrender to his cohorts. They agree. Tarrano then announces to the earth people, that he will not give them the Brende secret and declares war upon them, challenging them to attempt to conquer him.

The air war vessels of the earth government start to attack Venia, but Tarrano sends up a bomb of surrender and then, with Elza, Jac and Wolfgar, he escapes through an underground passageway to a space-flyer. They go on board and are taken to Venus to where Georg and the Princess Maida have previously been transported. They are royally welcomed and go to the palace of the Princess Maida. Here they are attacked by Argo, one of Tarrano's men, who shoots a violet-colored beam of light across the room, separating Maida from the rest of the party. He threatens to kill her, when suddenly Wolfgar throws himself into and through the violet beam of death.

Wolfgar dies soon after he confesses to Maida that he loves her and Maida has made a similar declaration. With great pomp and ceremony, the body of Wolfgar is laid to rest in the WATERS OF ETERNAL PEACE.

The evening after the burial of Wolfgar, Jac chances to be alone in a small boat near the palace and he is warned by a "slaan," a Venus man, to guard himself well. He also sees below the surface of the water and encased in a diver's cap, the face of an Earth man. Later that evening, preparations are rushed through for the great Water Carnival of Venus and to it proceed Georg and Maida; Elza and Tarrano; and Jac without a partner. They disguise themselves with long robes and masks and soon reach the scene of the festival.

At the carnival all of the inhabitants of the planet are seemingly given over to the pursuit of pleasure and love. However, there is a vicious undercurrent of events noticeable to Jac but which does not seem to claim the attention of Tarrano. At one place there is a swimming pool in which girls are constantly sporting themselves. Watching them, Jac sees one of them drag a Tarrano guard to the edge and with him grasped in her arms, plunge into the pool. A few seconds later the girl comes to the surface but the man is never seen again.

Toward the climax of the celebration, a notorious Venus character, the Red Woman, performs a dance particularly for the benefit of Tarrano. In the midst of it, the large hall in which it is being held, suddenly is darkened and rays of death shoot out over the place. Jac, forewarned, drops to the floor out of their range and throughout the entire assembly, "slaans" in the employ of Princess Maida wreak havoc with their long knives. The cry goes up, "Down with Tarrano. Loyalty, everyone, to your Princess Maida." The Venus people, followers of Maida, have revolted; the Red Woman is dead, but Tarrano—?

Tarrano escapes. Taking Elza with him he travels via aircraft to the Cold Country.

In the meantime, at the Water Festival other terrifying events are transpiring. The "slaans," thinking that they have been downtrodden, suddenly rise against their own Princess Maida. Maida and Georg attempt to stop them from an attack on the palace but they proceed. Georg turns a cold ray cylinder toward them but sweeps it upward into the tree tops and suddenly, groups of "slaans" who have been hiding in the trees drop to earth, killed by the ray. Snow starts to fall due to the condensation effect of the ray.

CHAPTER XXV

IMMORTAL TERROR

TO Elza, approaching with Tarrano on the tiny flying platform the City of Ice, the place seemed truly like a child's dream of Fairyland. The rude snow huts of the Arctic of our Earth were all that she had ever conceived could be built of frozen water. Here, in the outskirts of the city, she saw indeed, quite similar huts. But further in—ornate buildings several stories high. She caught a vague glimpse of them only, as the platform flew above them and descended in the center of the city.

They had passed over great outer encircling ramparts—a huge wall many *helans* long—built entirely of ice blocks—fortifications like that fabled wall which in the dim history of our Earth had once encircled a portion of the domain of the Yellow Race.

The platform came down before a central building—the Palace of Ice. Even in this dim daylight of the Cold Country summer, the great building gleamed and glittered resplendent. A building of many levels, storied and winged, with spider bridges and aerial arcades connecting the wings. Frescoed everywhere! ornate with carved design chipped in ice blocks hard as marble. Rolling terraces of snow and ice surrounded it—lawns of smooth white, with winding paths of ice. A many balconied building; towers, spires and minarets crowning it. All blue-white. Glittering. Seemingly fragile; from a distance, a toy—a sample of the ultra-skill of some master confectioner, as though the whole thing were a toy of sugar for children to admire. But at close range—solid; in the cold of this terrible region, as solid as though constructed of blocks of stone.

With the flying platform landed, and its warming rays cut off, attendants rushed forward. Tarrano and Elza were wrapped in furs at once—heavy furs which covered them from head to foot.

"Well! Well, Graten!" Tarrano greeted his subordinate smilingly. "Things are in condition here? You got my message?"

"Yes, Master."

In his furs, with face almost hidden, Elza

could not see what manner of man this was.

"Yes, Master. All is in good fashion here. We welcome you."

They entered the palace. Frescoed; carved everywhere, within as without. The main doorway led into a palatial hall, carpeted with furs. It was warm. Tarrano discarded his fur, and helped Elza out of hers.

"You like my home, Lady Elza?"

"It's—beautiful," she answered.

His smile showed amusement at the wonder and awe which stamped her expression. He added very gently:

"I had in mind when I built it, the hope that you would be pleased."

A comfortable interior warmth. Elza noticed little blurs of red light behind wire cages here and there. The warmth came from them; and a glow of pale white light from the tubes along the wall.

A woman hurried to them. Tara! Elza recognized her at once. Tara, looking very pretty in a pale blue robe, with her hair done high upon her head. The woman who loved Tarrano; he had sent her on here to be rid of her, when he went to the Great City. She came forward. Pleasure was on her face at seeing Tarrano; but her glance as she turned it momentarily toward Elza, held again that smouldering jealousy.

Tarrano was evidently in a mood of high good humor.

"You welcome me prettily, Tara." She had flung her arms about him. "Tara, my dear is——"

"Master—you come but in time. They are working the Brende instrument. Already they have——"

"They? Who?" He frowned. His words were hard and cold as the ice-blocks around him.

"Woolff. And the son of Cretar. Many of them—using it now!"

Tarrano drew Elza with him. Tara led the way. Through glowing white hallways, an arcade; down steps and an incline—to burst at last through a tunnel-like passage into a room.

"So? What is this, Cretar?"

A room littered with apparatus. A dozen men were about. Men scantily dressed in this interior heat. Short, squat men of the Cold Country; flat-nosed, heavy faces; hair long to the base of the neck. In a corner stood the Brende instrument, fully erected. A light from it seemed penetrating the bared chest of a man who was at that moment standing in its curative rays.

He whom Tarrano called Cretar, took a step forward.

"Master, we——"

"Making yourselves immortal?" The anger had left Tarrano's voice; irony was there instead.

"Master——"

"Have you done that?"

"Master—yes! Yes! We did! Forgive us Master."

The man before the instrument had retreated from it. Elza saw now that all the men were shrinking back in terror. All save Cretar, who had fallen tremblingly to his knees. Yet Tarrano showed no anger. He laughed.

"I would not hurt you, Cretar! Get up, man! I am not angry—not even annoyed. Why, your skin is turning orange. See the mottles!"

On the flesh of all the men—save the one who had been checked in the act of using the instrument—a bright orange mottling was apparent. Cretar exclaimed:

"The immunity to all diseases, master. It is itself a disease—harmless—and it combats every other." He laughed a little wildly. "We cannot get sick now. We cannot die—we are immortal. Come, Master—let us make you so!"

Tarrano whispered: "You see, Lady Elza? The orange spots! These men of medicine here have used the Brende secret to its full. Immune from disease!"

"Let us treat *you*, Master. This immortality——"

On Cretar's face was a triumphant smile, but in his eyes lay a terror. The man who had not been treated stood against the wall watching with interest and curiosity. But the others! They crouched; wary; alert eyes like animals at bay.

Tarrano laughed. "Treat me! Cretar, you know not with what you have been trifling. Immortal? You are indeed. Disease cannot touch you! You cannot die—save by violence!"

He swung to Elza. "These men, Lady Elza—they are strong-muscled. In health now more perfect than any other humans. *You* are frail—a frail little woman. And unarmed. I bid you—strike one of them!"

She stared; but as she suddenly faced about, she caught in part his meaning. Before her Cretar shrank back, his face gone white, his teeth chattering.

"What's that behind you?" Tarrano's voice simulated sudden alarm; he scuffled his feet on the floor. The men jumped with fright; nerves unstrung, they cowered.

"What manner of men!" Tarrano's laugh was contemptuous. "Oh, Lady Elza, let this be a lesson to all of us! To cure disease is well. To prevent it—that too is good. But immortality—Dr. Brende never intended it, *you* know he did not, Lady Elza—the belief that we have everlasting life here on this plane—the Creator never intended that. With all danger of death gone—save violence—these immortals here fear violence so greatly that they are men no longer!

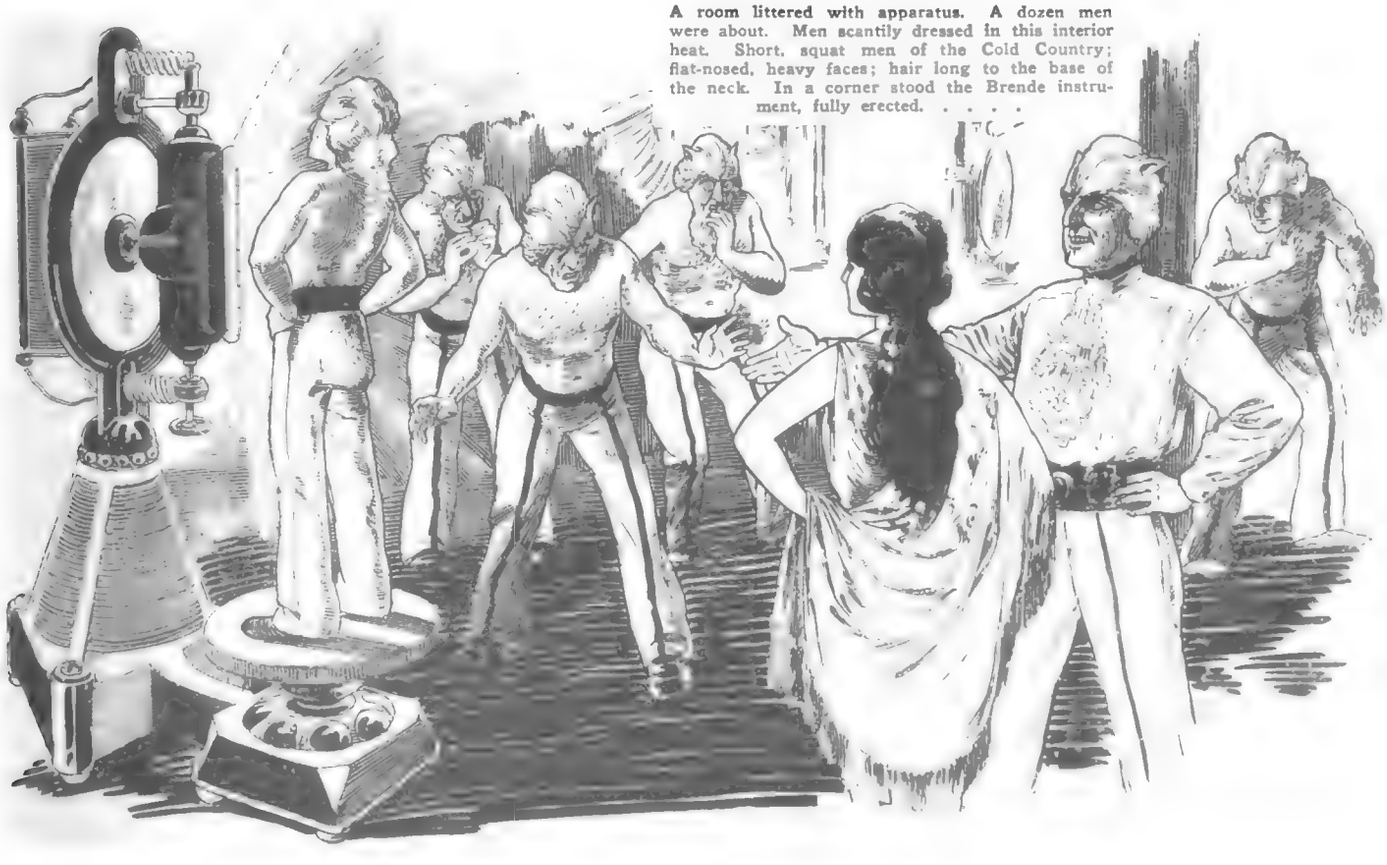
"Immortal terror! God forbid *I* should ever feel it! Or you, Lady Elza. A lesson for us all, who would be so un-Godly as to seek and think we have found what only the Creator Himself can bestow!"

CHAPTER XXVI

THE BLACK CLOUD OF DEATH

I must revert now to that time in the gardens of Maida's palace at the Great City when we stood upon its roof-top, threatened below by that mob of slaans. Georg stood with the cylinder in his hand, waving it. The palm foliage was freezing. Down through the swirling snow fell the frozen bodies of the slaans who had climbed into the gigantic palm fronds. The thuds as the bodies struck the ground sounded horribly plain in the stillness. Georg was still waving his cylinder. Snow and ice were gathering everywhere. Incautiously he lowered the weapon; a brief, momentary chill—the congealing

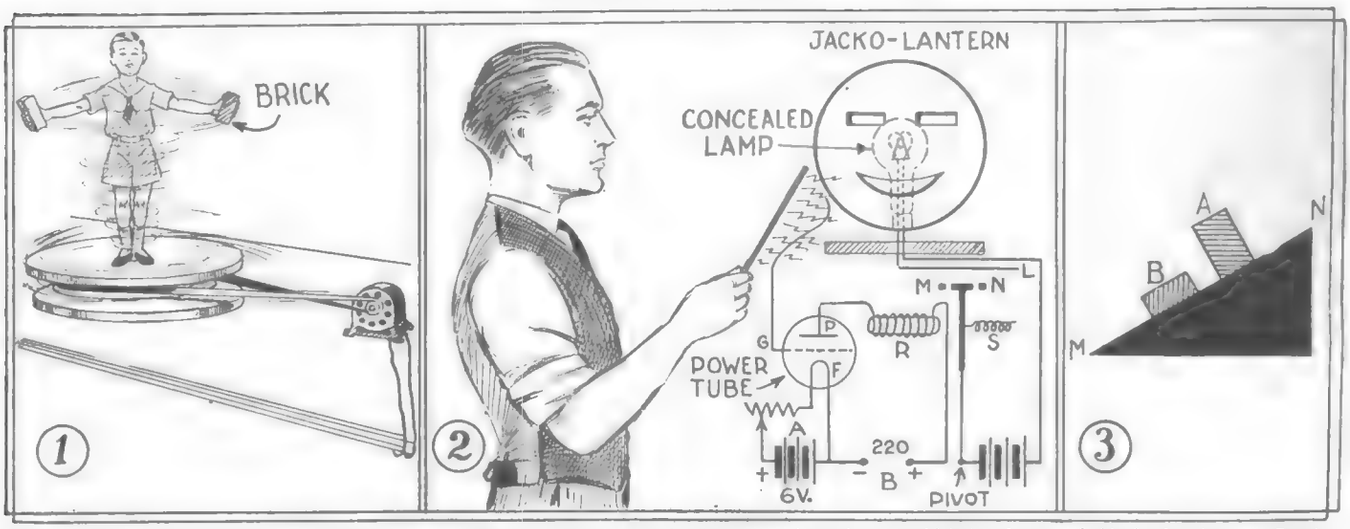
(*Continued on page 75*)



A room littered with apparatus. A dozen men were about. Men scantily dressed in this interior heat. Short, squat men of the Cold Country; flat-nosed, heavy faces; hair long to the base of the neck. In a corner stood the Brende instrument, fully erected. . . . .

Scientific Problems and Puzzles

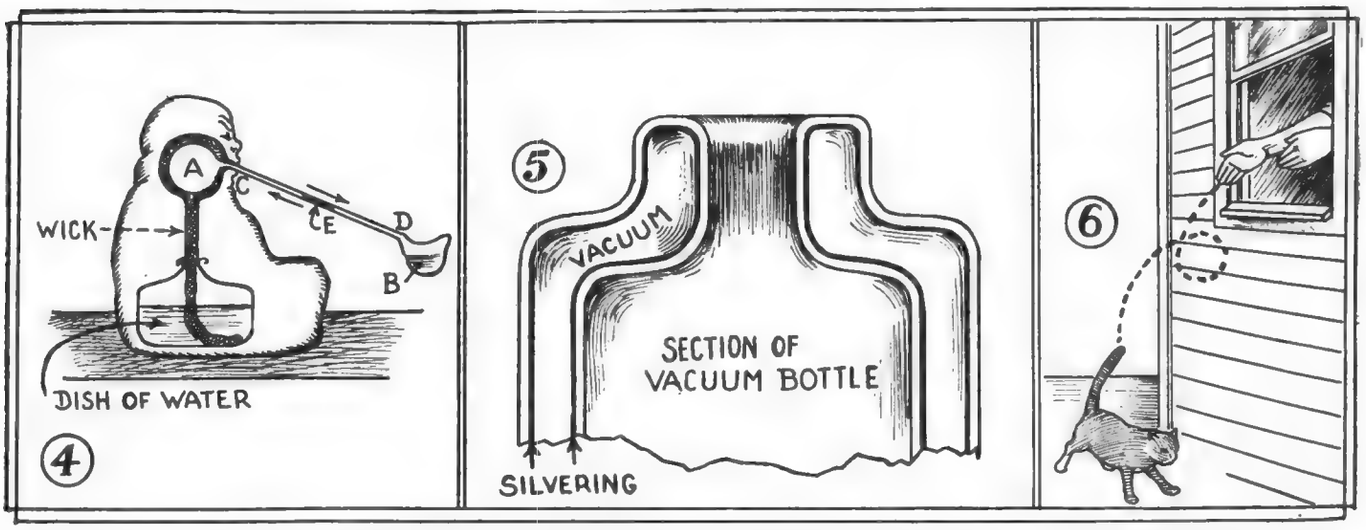
By ERNEST K. CHAPIN



The boy in the above illustration is being rotated. If he drops his hands to his sides, will the speed of rotation be affected, and if so, how and to what extent?

In the above shown circuit diagram, a fountain pen which has been rubbed with a woolen cloth is brought near the circuit and the relay R is tripped. To which contact, M or N, should L be connected in order to light the lamp within the jack-o-lantern?

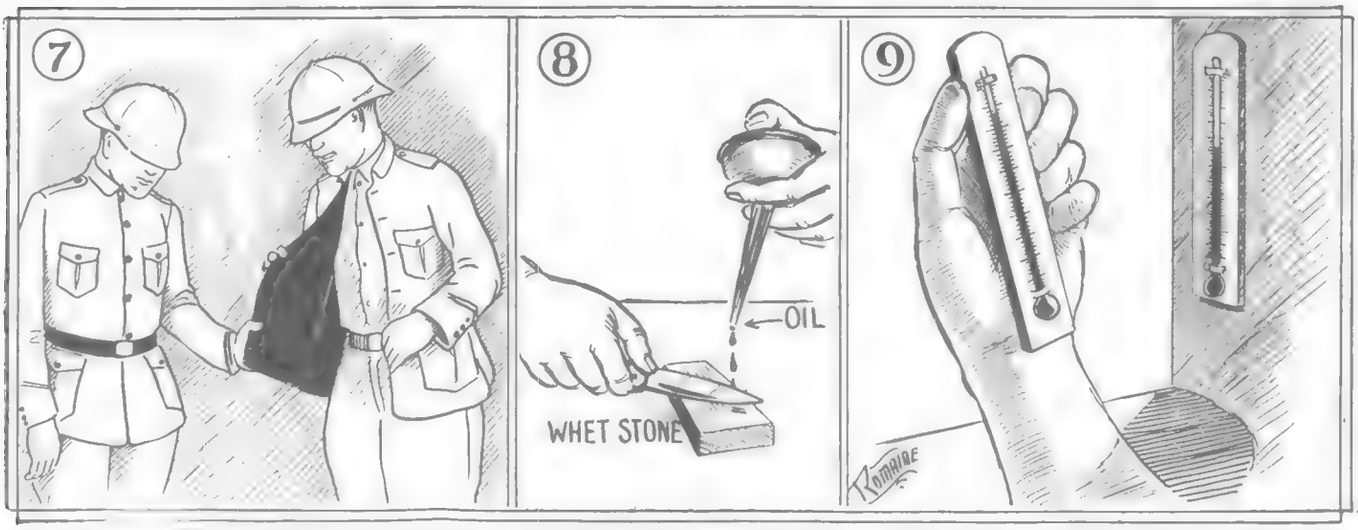
A block placed as at B will slide from N to M. What will happen if it is placed as at A? Will it slide?



In a device made as shown above, as the water evaporates from the wick, the drop of liquid E moves up and down the tube from C to D. What is the motive power of this interesting toy?

A vacuum bottle consists of a double walled vessel with the air removed from between the walls. Why are the interior walls that face the evacuated space coated with a thin layer of silver?

How is it possible for a cat to turn completely around in the air when it has nothing to pull or push against.



It is re... that clothing for use in the hot tropic... ade of a white material lined on t... . Why should such a combin... dvantage in hot weather?

Why is it of advantage to put oil on a whetstone when sharpening edged tools on it as in the above illustration?

A thermometer in the direct rays of the sun will register a higher temperature than another one placed in the shade. Is the difference a true record of the difference of temperature between the two places?

ANSWERS TO THESE QUESTIONS ON PAGE 84

MAGIC By "DUNNINGER"

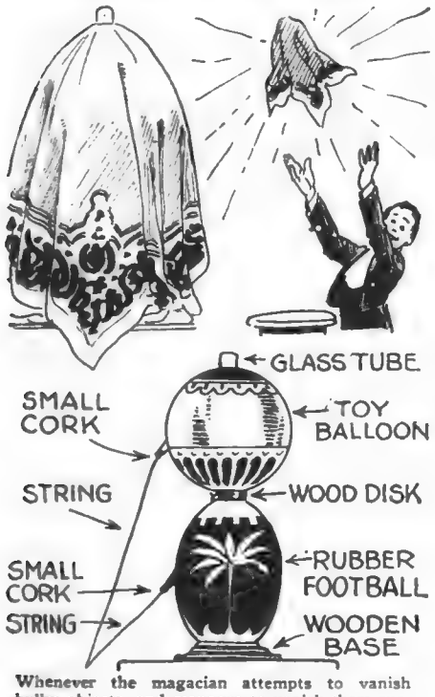
DUNNINGER
Joe Dunninger Tells How Prince Got Trick to Show Home Folks
DUNNINGER'S
HYPNOTIST RULES SUBJECT BY RADIO
Reads Mayor's Inner Mind

THE MAN WHO MYSTIFIED
Pres. Coolidge
Prince of Wales, Ex-President Harding, Taft, Roosevelt, and other celebrities
Writes Exclusively for
SCIENCE AND INVENTION

Mind You! The Mind Reader Really Read the Mayor's Mind
DUNNINGER DRAWS MORE BIG CROWDS
Dunninger Will Attempt To Hypnotize Patient, 10 Miles Away, by Radio

NO. 38 OF A SERIES

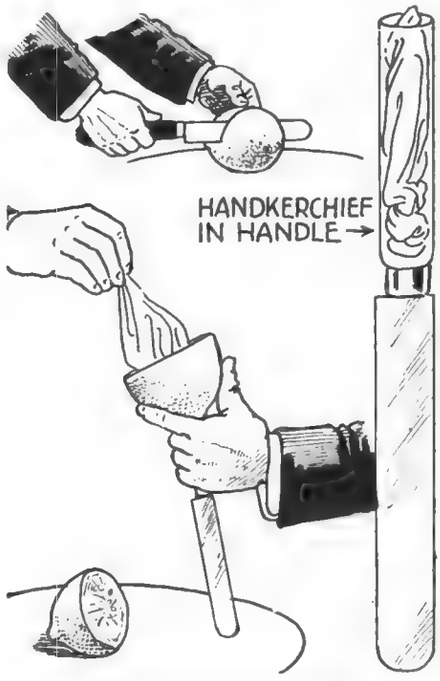
The Vanishing Lamp



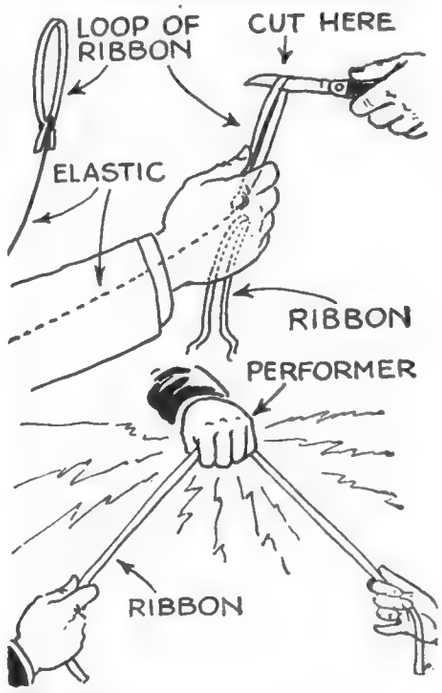
Whenever the magician attempts to vanish bulky objects, and manages to vanish them successfully, he is sure to be greeted with great applause. The trick illustrated in the diagram above is one of those large mid-air vanishes. A lamp is covered with a cloth, the covered affair lifted and tossed into space, the lamp vanishing instantly. The construction is merely rubber inflated and composed of a toy balloon and a football. The string pulls out both plugs permitting the air to escape.

The Enchanted Lemon

Tricks in which articles borrowed from spectators become the subjects of manipulation are always considered novel. In the above trick a handkerchief is borrowed, vanished and then found in an unprepared lemon. The vanished silk may easily be loaded into the hollow handle of a knife, and after the lemon is cut and knife and lemon held as illustrated, the silk piece can be apparently pulled out of the lemon. The silk is dry when produced.

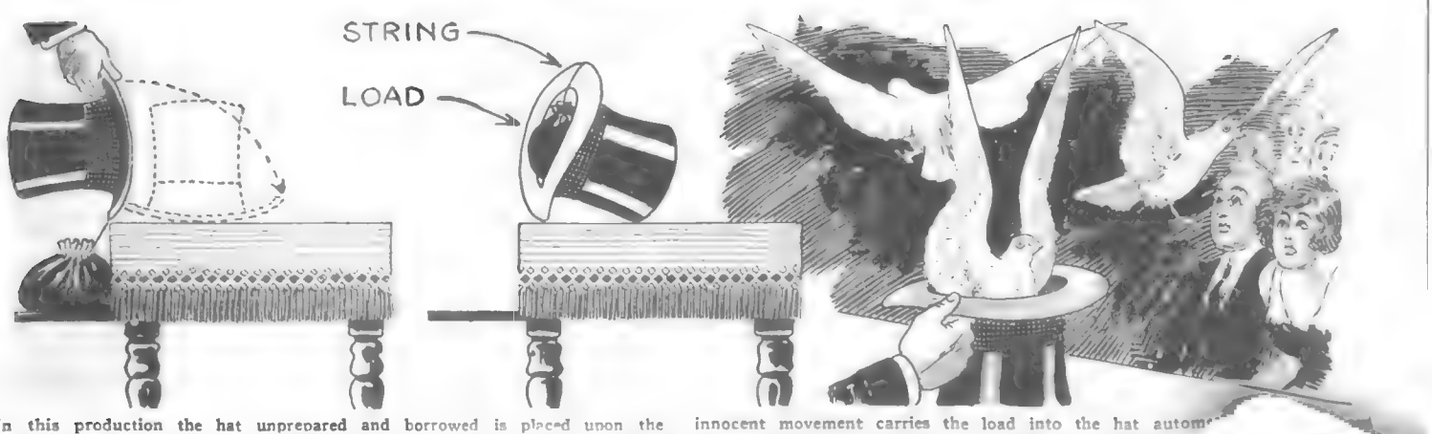


Cut and Restored Ribbon



A string after having been measured is cut in half, a knot made and by passing the hand over the cut portions, the ribbon again repairs itself. The secret lies in the fact that another duplicate ribbon attached to a rubber band is the one actually cut. When this cut ribbon is tied, the performer places his hand over the knot and manipulating it, releases it, permitting the elastic band to draw the small piece up his coat sleeve.

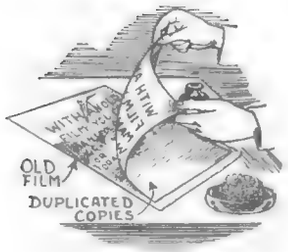
Pigeons from Hat



In this production the hat unprepared and borrowed is placed upon the table, as indicated by the dotted lines. During the act the string from the load is attached to the brim of the hat. The hat is then tipped to show the inside, which of course is empty. Then the hat is rested upon its rim, top up again and tipped in the reverse direction showing the crown. This innocent movement carries the load into the hat autom the production can be made. Live birds are easily carr silk bag with a draw-string top. The bag is easily gott ping it into a servante. Loads may be picked up fron the stage by duplicating the movement.

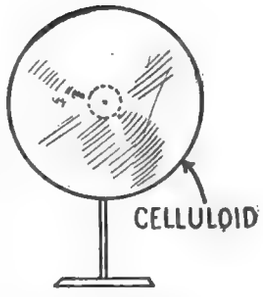
Prize Winners in

Some Good Suggestions for the



Duplicator

First Prize—$25.00. It is not generally known that an old photographic film makes a very splendid hectograph or duplicator. The film is lettered backward on the rough side with regular hectograph ink, or better yet a sheet of paper is first lettered, the film then moistened slightly to make it tacky, and the lettered paper placed upon the film. Several hundred manifold copies can be made in the same manner as with the standard hectograph. Mr. Carl Fichtner of Philadelphia wins the award for this suggestion.

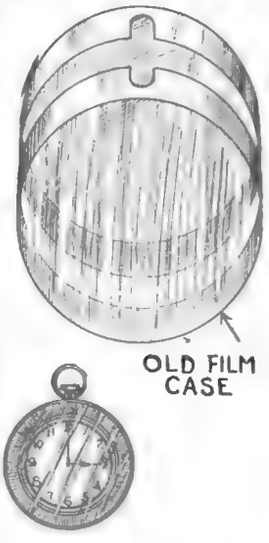


Loud Speaker

Old films cemented together make an excellent cone for the home-made loud speaker.

Watch Case

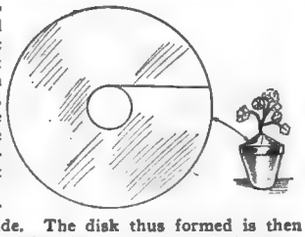
Third Prize—$10.00. Everyone knows how difficult it is to keep a chamois cover on a new watch, and everyone knows that even these methods of protecting a gold watch from scratching are unsatisfactory. If the reader will take the time and trouble to build a case for his watch of old films, and make it as illustrated in the diagram here given, he can put that case around the watch and leave it there for a year or more. The watch and glass are both protected and the time can always be read. —Frank Schmulowitz, New York City.



Speaker Cone

Second Prize—$15.00. Many amateurs and radio enthusiasts building their own loud speakers find it difficult to secure the paper for the cone. One of the best methods of making this cone is to secure some old photographic films of as large a size as possible and cement these individual films together, forming one large sheet which can then be cut to the desired shape. A cone made of a photographic film is practically impervious to moisure. It can be painted to make it look artistic, and the cement marks on a painted cone cannot be seen. If at all possible a fire-proof film should be used. The suggestion was submitted by Millard V. Barton of Hollywood, Calif.

Flower Moisture Preserver



Fourth Prize—$5.00. An old photographic film can be cut in a circlar farm as illustrated, and a round hole can then be made in the center with a cut communicating from the center hole to the outside. The disk thus formed is then rolled into a cone after being put around the stem of a potted flower. This celluloid disk retains the moisture in the pot for a longer period of time than if the soil is exposed to the air. The winner of this award is O. Miller, Dalton, Minn.

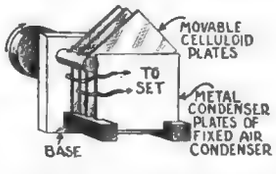
It Will Pay You

to refer to the pages of this magazine containing the articles on the Matchcraft Contest and the Model Department.

Prizes are being awarded every month and it is just as easy for you to win one of the handsome monthly awards, as it was for your neighbor to win his vacation money.

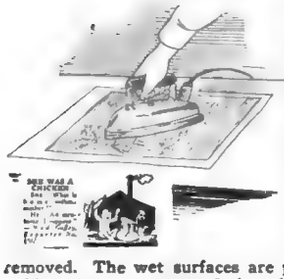
Do not delay, start at once.

Variable Condenser



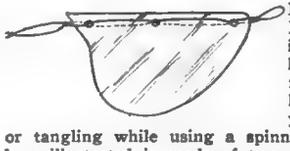
Sixth Prize—$5.00. In the special type of condenser here shown the variations in capacity are effected by changing not only the dielectric constant but the dielectric itself. The fixed unit has air dielectric giving a definite minimum capacity. Celluloid sheets in the form of plates are gradually introduced between the two sets of condenser plates, replacing the air dielectric and raising the constant of the condenser which attains a new maximum not obtainable with the air dielectric.—Jack Bront, New York City.

Glazing Photographs



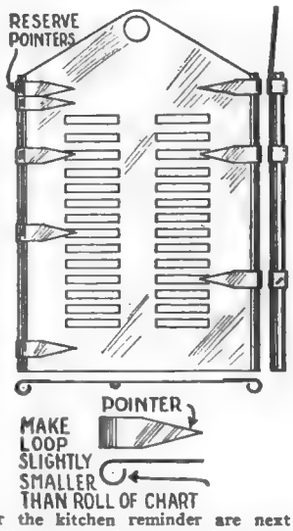
Seventh Prize—$5.00. Old films come in very handy for protecting photographs, newspaper clippings and other data which are to be preserved. The photograph is moistened and the film moistened on the side from which the emulsion was removed. The wet surfaces are placed face to face, a blotter put on top and the whole pressed with a hot iron.—Carl Fichtner of Philadelphia, Pa.

Fishline Keel



Fifth Prize—$5.00. If you go out fishing and particularly if you troll for fish you will have had trouble with your line twisting or tangling while using a spinner. The line keel here illustrated is made of two or three sheets of film cemented together and then threaded with gut as illustrated. It is hooked in the line and the tackle is secured to the far end of the keel. It is a sure safeguard against twisting in case swivels refuse to work, and furthermore it is quite invisible in the water. Prize awarded to George A. Hogan, Augusta, Maine.

Kitchen Reminder



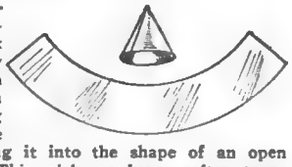
Ninth Prize—$3.00. In the kitchen reminder here illustrated three negatives have been cemented together. Printed tabs are then pasted in place on the reminder and another layer of celluloid is added to permit the reminder to be washed and to prevent soiling of the printed notations. The edges are then curled around an eighth inch stick of wood using steam to effect the process. —L. J. Baker, Helena, Mont.

[The pointers for the kitchen reminder are next made and they should be painted on the under surface with some contrastingly colored paint such as red or black. They are also formed to fit the round edges of the reminder. A reserve pointer should be made for each of the items listed on this handy kitchen device and these may be kept in a small box. —EDITOR.]

Artistic Films

Tenth Prize—$3.00. Many old films are too poor to print from but they generally form the basis of a scene that would look pretty if done in oil colors. Even the amateur artist can follow the markings on the film and paint his films in artist's oil colors and then mount those films on white cardboards and frame them. Two excellent examples of this kind of work were submitted by Miss Louise H. Coursen of Lewistown, Ill.

Banjo Pick



Eighth Prize—$3.00. A very excellent banjo pick may be made by cutting an old film in the shape shown above and coating this with a flexible cement and rolling it into the shape of an open ended thimble. This pick produces softer tones than steel ones of the same shape, and is easier to hold than if made flat. The size of the open end of the thimble should of course be made to fit the finger. This was the suggestion of Rolf D. Williams of Colfax, Calif., and the judges considered the idea worthy of the eighth award.

Old Film Contest

Use of Old Photographic Films

Face Mask

Eleventh Prize — $3.00.

In working around the face it is frequently unavoidable to breathe into the faces of your patients or to get the breath of the patient. This unpleasantness can easily be overcome by the use of an old film cleansed and secured to rubber or other tape as illustrated in the drawing. The tape may be fastened to the celluloid mask by paper clips. This makes a very satisfactory shield superior in appearance to the white masks which surgeons wear. —Charles E. Washburn, Portland, Maine.

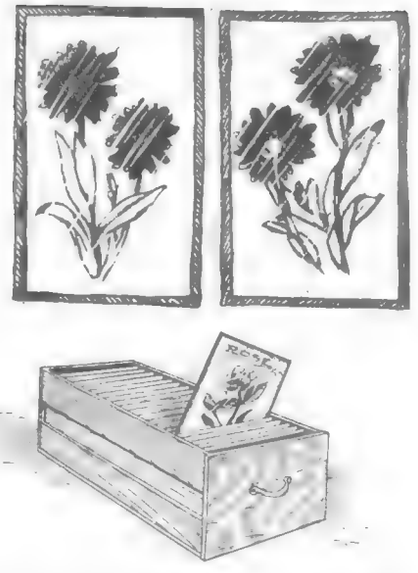
Titling Negatives

Twelfth Prize—$3.00.

Printing backward on a piece of old film and then printing the paper through the negative and the lettered film, the lettering can be made to appear on the photograph in a very artistic manner. It is shown in white, for accentuation, on our illustration above.—W. A. Gordon, Port Dover, Ont.

Flower Catalog

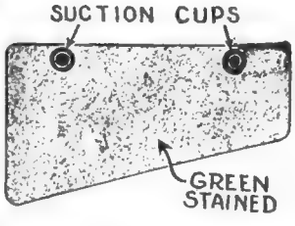
Nineteenth Prize—$2.00.



One of the finest indexes of flowers, small butterflies, bugs and other specimens, may be made by placing the pressed flowers between two old films and then binding the edges after the legend has been inserted. Such indexes are unbreakable and give a view of both sides of the confined object. A front and back view of one of the index cards is illustrated above.—Mrs. H. S. Searle, Napa, Calif.

Windshield Anti-Glare

Thirteenth Prize —$3.00.



The anti-glare is a wonderful help to the driver of an automobile, and may be made by securing a sheet of fogged film and fitting two rubber suction cups to it as shown. If a fogged film cannot be obtained, a piece of film may be washed and then stained green. The anti-glare is generally cut as the diagram shows. The home-made one is as good as some of the more expensive ones. The winner of this award is a gentleman from Clinton, Mass., who failed to put his name on his manuscript.

$300.00 Prize Contest

A NEW and fascinating prize contest will be started in the June issue of SCIENCE AND INVENTION. This contest promises to become as important as our Matchcraft Contest, which has taken the country by storm.

It is a contest that young and old may participate in — something that every one can do. There will be many prizes, and our readers will show the usual amount of ingenuity in competing in this prize contest.

Moreover, and most important, this is a contest of utility.

For details, see June issue.

—EDITOR.

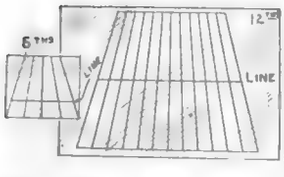
Bottle Cover

Seventeenth Prize—$2.00.

A simple, cheap, yet effective sanitary cover for syrup, milk and other bottles, can be made from old films which should be rolled into a tube and fitted with a top preferably cemented in place. The tops should be made in different sizes to accommodate various sized bottles. Instead of rolling the covers as shown, a cone can be formed of the old film, which cone can be used for the same purpose.—C. Ailion, Kobe, Japan.

Divider

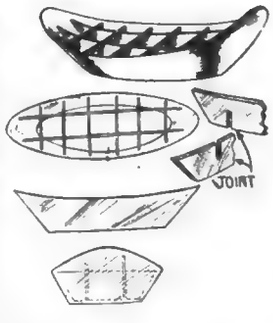
Fourteenth Prize—$2.00.



The winner of the fourteenth award hails from Gifuken, Japan. His suggestion was to rule separate sheets of celluloid as indicated on the diagram into thirds, fifths, sevenths, ninths, etc. Then if it is desired to divide any line into proportional lengths one need merely slide the celluloid plate upon that line until the ends of the line cross the divergent scribe marks on the celluloid plate.—Sachio Hasunuma, Reporter No. 20656.

Soap Tray

Sixteenth Prize —$2.00.



A soap tray which will keep the soap dry and thus prevent it from dissolving unnecessarily is illustrated herewith. The old film is formed into the shape of a boat and is then fitted with a grid as the drawing indicates. Each joint in the grid is cemented with celluloid cement and where the grids touch the sides of the vessel a drop of cement is also applied. This transparent little device has a very attractive appearance. It is obvious that with several of these soap trays in your home, soap will not waste away to the same extent that it does with the ordinary hollow enamelware trays. These latter always contain a small amount of water which not only dissolves the soap but softens it considerably and causes the soap to give out quicker. Due to the grid construction in this soap tray the water drips from the soap into the bottom of the tray, leaving the cake perfectly dry. The vessel may be easily washed by holding it under a stream of running water for but a few minutes.—Otto von Bothmer, Berlin, Germany.

Pin Cushion

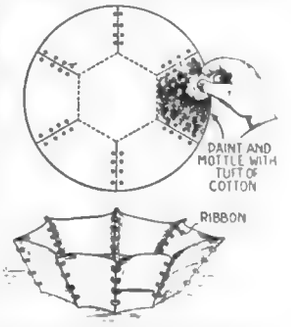
Fifteenth Prize—$2.00.

Artistic pin cushions for your friends can be made by placing a photograph or a small silk flag between two old films and then sewing the cushion around the celluloid protected object. Not only does the celluloid serve as a protection for the photograph but it also acts as a tray when the user does not desire to push the pins into the cushion. Such pin cushions make very splendid gifts, particularly if they contain a photo of yourself as such a gift cannot be duplicated.—Miss Edith Bornamann, Bethany, Nebr.

Bon-Bon Dish

Eighteenth Prize—$2.00.

If a circular piece of old film is cut along the solid lines, and folded along the dotted lines, and if ribbon is then tied through the holes, as illustrated in the diagram, a very serviceable flat bon-bon dish can be made. This dish is made more decorative by mottling it. The entire sheet of celluloid should be painted and then dabbed with a tuft of cotton. This should be done before the celluloid sheet is folded and tied. Ribbon bows enhance the decorative effect of the bon-bon dish.—Miss Leona Huls, Missoula, Mont.



MODEL DEPARTMENT

Rules for Model Contest

1. A handsome trophy cup engraved with your name, will be awarded as the prize for the best model submitted during the month. The decision of the judges will be final and will be based upon, A—novelty of construction; B—workmanship; C—operating efficiency of the model as related to the efficiency of the device which the model simulates, and D—the care exercised in design and in submitting to us sketches and other details covering the model.

2. Models of all kinds may be entered. They may be working models or not, according to the subject that is being handled.

3. Models may be made of any available material, preferably something that is cheap and easily obtainable. Models made of matches should not be submitted to this department but should go to our Matchcraft Contest Editor.

4. Models must be submitted in all cases. Good photographs are also highly desirable and where the maker does not desire the model to be taken apart, legible drawings with all dimensions covering parts that are not accessible must be submitted.

5. Models should be securely crated and protected against damage in shipment and sent to us by parcel post, express or freight, prepaid. Models will be returned when requested.

6. Models for entry in any particular contest must reach this office on or before the 25th of the third month preceding date of publication. For instance, models for the July contest must reach us on or before the 25th of April.

7. Address all entries to Editor Model Department, c/o Science and Invention Magazine, 53 Park Place, New York City.

Cup Winner for May

ROBERT J. BOHATY

? ? ? ? ? ? ? ? ? ?
? WHO NEXT ?
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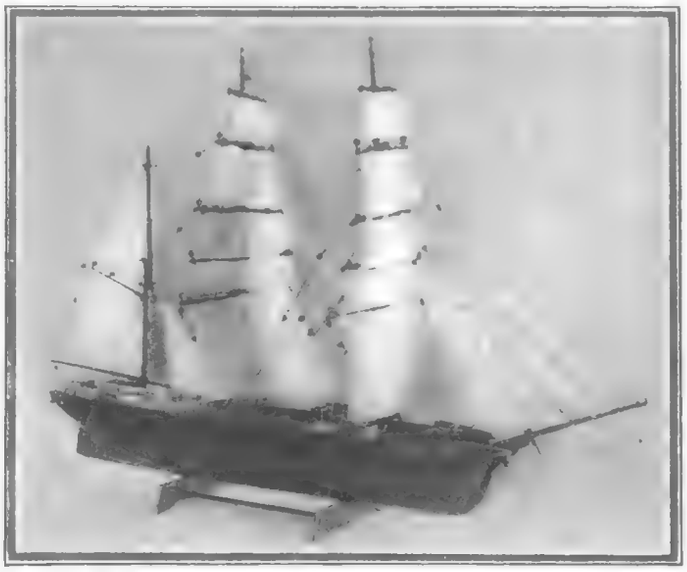
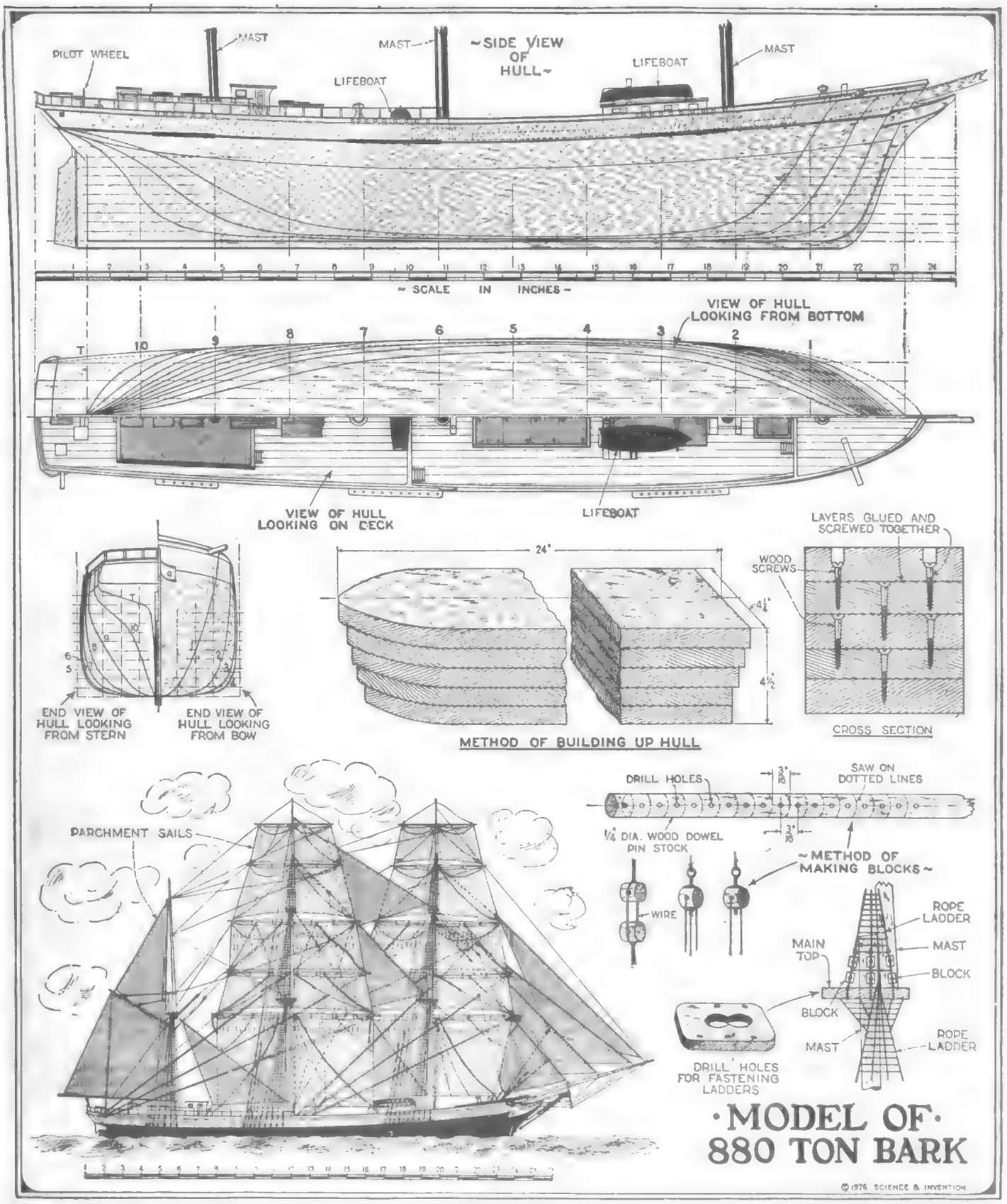


The photo above shows the prize winning entry in this month's contest. It is a model of a 880 ton bark made by Robert J. Bohaty (photo below) of Long Island City, N. Y.

EVERY month this magazine will award a trophy cup for the best model submitted to the Model Department during the month. The photograph of the ship which won the prize in this issue and the cup were both taken at the same time on the same plate and the comparative size of the cup can thus be readily made. We have offered a prize of lasting value to those who submit their models. Let us now hear from our model making readers.

Details of First Cup Winning Model

Model of 880-Ton Bark Wins First SCIENCE AND INVENTION Trophy Cup



Above are drawings of a scale model of an 880-ton bark to which the judges awarded the first SCIENCE AND INVENTION Magazine model trophy cup. The cup itself is nearly as large as the model.

The winner of the first cup is Robert J. Bohaty of Long Island City, New York. Mr. Bohaty has been working upon models of all kinds for quite some time and this is the first award any of his models have won. He entered five model steam engines in the SCIENCE AND INVENTION contest, in addition to the bark here illustrated.

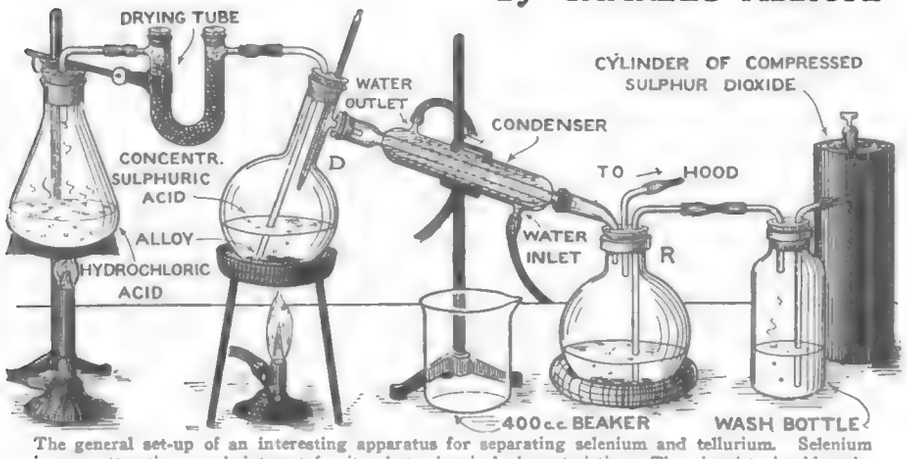
The bark itself is made as shown in the sketches above. The hull is composed of layers of wood glued together and then carved down to the lines illustrated in the drawings which have the scale in inches marked upon them. The pulleys for the model were made of dowel rod drilled and then sawed up. All double and triple blocks found on the model are made in the same way. For display purposes the sails of the model are made of parchment but cloth sails, or preferably silk sails, could easily be put in place and each and every one could be made to operate by merely pulling on the proper ropes.

(Blueprints of this model may be obtained from the Model Department)

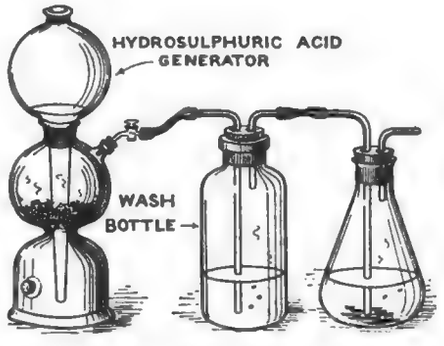
Separation of Selenium and Tellurium

Distillation Method

By CHARLES ABBATE



The general set-up of an interesting apparatus for separating selenium and tellurium. Selenium is now attracting much interest for its photo-chemical characteristics. The chemist should make some for himself.



The apparatus and set-up for generating hydrosulphuric acid for the precipitation of tellurium sulphide from the solution, after the separation of selenium.

THE following is an excellent method for determining selenium and tellurium in alloys:

The apparatus having been set up, as shown, 0.5 grams of the alloy containing selenium and tellurium is placed in the distilling flask (D) and 30 cc. of sulphuric acid H_2SO_4 (specific gravity 1.84) are added. All connections are made tight.

A current of dry hydrochloric acid gas is allowed to pass into the distilling flask and the contents of the flask are heated to 300° C. (572° F.) The sulphuric acid, H_2SO_4, should not fume and the temperature should be kept below its boiling point, otherwise the acid distilling into the reservoir (R) would interfere with the precipitation of selenium by SO_2.

Selenium distills as selenium chloride into (R), while tellurium remains in the distillation flask. During the distillation, SO_2 gas is passed into (R) to reduce the selenic salt in solution and precipitate metallic selenium.

The distillation is continued for two or three hours, keeping the temperature of the distillation flask at about 300° C. (572° F.), which is below the boiling point of sulphuric acid. The contents of the receiver (R) are transferred to a 400 cc. beaker and the distillation continued into fresh hydrochloric acid to assure complete volatilization of selenium from the flask (D). The contents of the receiver and any of the metal adhering to the glass wool or to the glass of the vessel are combined. The adhering selenium is dissolved off with a little bromine—in solution in potassium bromide solution.

The solution in the beaker is saturated with SO_2 then heated to boiling, and the precipitated selenium is allowed to settle several hours, or over night. The precipitate is filtered, then washed with hot water and, finally, with alcohol. The residue is dried for an hour at 100° C. (212° F.)

The residue in the distilling flask, which includes the tellurium, is transferred to a 600 cc. beaker containing 150 cc. of cold water. Ten cc. of 3% $Fe(NO_3)_3$ ferric nitrate solution is added, made ammoniacal and boiled. The precipitate is filtered through a large filter paper and washed with hot water. The precipitate is dissolved in hot diluted hydrochloric acid and the solution nearly neutralized with ammonium hydroxide NH_4OH. The slightly acid solution is saturated with hydrosulphuric acid, H_2S, the precipitated tellurium is filtered out and washed on the filter paper with H_2S water.

The precipitate is dissolved from the paper into a small beaker with a mixture of equal parts of hydrochloric acid and bromine-potassium bromide solution. The bromine-potassium bromide solution is made by adding 200 cc. of liquid bromine to 320 grams of potassium bromide salt dissolved in just sufficient water to form a saturated solution.

Tellurium is precipitated by saturating the solution with sulphide dioxide, SO_2. The precipitate, after the liquid holding it is heated to boiling, is allowed to settle for several hours and filtered. It is washed with hot water, then with alcohol and dried for an hour at 100° C. (212° F.) and then allowed to cool.

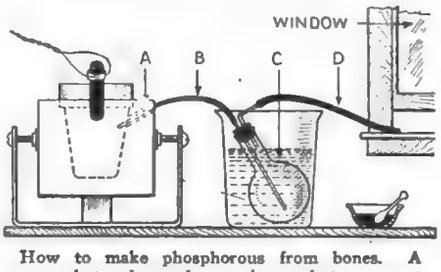
Phosphorus from Bones

By STEARNS MacNEAL

THE chemically disposed readers of this magazine know that phosphorus is present in bones. This is so much the case that calcium phosphate is often termed bone phosphate. The famous Swedish chemist, Scheele, was the first chemist who prepared phosphorus from bone. This was in the year 1771.

For those who have constructed the electric arc crucible described by Philippe A. Judd in the August issue of the EXPERIMENTER the extraction of phosphorus from bones is comparatively simple.

It is a distillation process which we are going to describe. The crucible must be so arranged that it can be tightly closed with a lid of some kind, leaving only a single opening for the phosphorus to pass out in the state of gas. Into this opening is inserted



How to make phosphorous from bones. A somewhat advanced experiment but one not presenting any real difficulty if one has the requisite electric furnace.

a piece of brass tubing about 3/16 in its internal diameter, which is luted in with fire clay. Except for this opening the crucible must be sealed up tightly. The tube leads into a flask marked C in the illustration which is immersed in a cold solution, such as ice water, the colder it is the better. As the phosphorus comes over in the state of gas, some of it will condense in this flask; if the solution surrounding it is cold enough the greater part will condense therein, but a small amount will escape and the tube D leads out of doors or to an evaporating hood, or perhaps into a chimney. Both tubes are fitted tightly to the condensing flask by a double aperture cork.

Some bones are wanted to give us the phosphorus. These are to be cleaned thoroughly. It is well to boil them so as to get rid of much of the soluble organic matter, as the odor produced by marrow is disagreeable and penetrating. The insoluble organic

matter is next to be reduced to carbon.

The bone is then broken up and put into the crucible and heated in a fire or the pieces may be placed on a wire gauze and be heated by a Bunsen burner. This drives off the moisture and if carried far enough will carbonize the organic matter. The bones are now brittle so that they can be pounded up. They are next mixed with an equal quantity of fine sand and the mixture is transferred to the crucible.

This is the time when the crucible is to be closed hermetically as described in the first part of the article. The current is now turned on and in a little while the vapor of phosphorus makes its appearance and descends into the flask, C, and most of it condenses on the sides of the flask. Any which escapes, goes out through tube D.

When the sides of the flask become quite white, with the solid phosphorus condensed on them, it is detached and three or four cubic centimeters of carbon disulphide are added and shaken around until all the phosphorus adhering to the sides is dissolved. The contents are then transferred to a test tube and allowed to evaporate when almost colorless crystals of white phosphorus remain. It may inflame spontaneously, so have a basin or dish of water at hand to drop tube and contents into if it ignites. The essential point in this experiment is only to carbonize the bone.

Those who are not fortunate enough to possess an electric furnace can prepare phosphorus from bones in the following manner:

The bone chips are burned to whiteness by being kept at red heat for about twenty minutes in an iron crucible placed in a bed of hot coals.

They are then powdered and treated with sulfuric acid so as to decompose the calcium phosphate in the ash. The solution is then evaporated to a syrup, mixed with charcoal and distilled. The rising phosphorus vapors can be condensed and collected by the same method as described above.

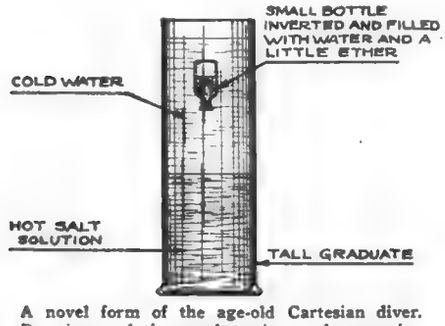
Do not be alarmed if the phosphorus ignites; a basin of water will take care of it, if it does. Do not let it get upon the hands, as a phosphorus burn is very bad.

Chemical Cartesian Diver

A TALL graduate is filled half full of cold water and a hot saturated solution of salt is poured into the bottom by means of a long thistle tube.

A small bottle, such as medicines come in, is filled with ether and water (proportions best determined by experiment), until it will just sink in cold water when inverted.

Then, if placed inverted in the tall graduate, the bottle will sink until it reaches the hot salt solution, the heat will cause the



A novel form of the age-old Cartesian diver. By virtue of the condensation and expansion of the ether in the small bottle, the latter moves up and down in the graduate.

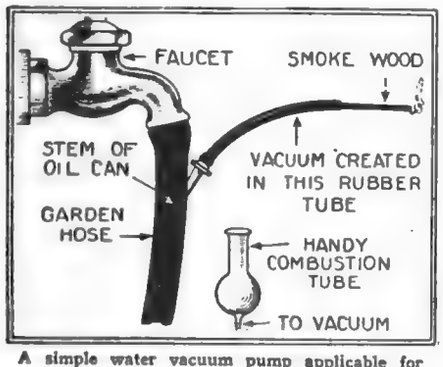
ether to expand, driving out some of the water in the bottle. The increased buoyancy will cause it to rise in the cold water, where the ether will contract, allowing more water to enter into the bottle so that it will sink.

Contributed by FRANCIS M. GILREATH.

A Simple Water Vacuum Pump

BY T. M. VEATCH

ONE day while experimenting, I discovered, quite by accident, that when a stem from a small oil can was inserted in a piece of garden hose, through which a current of water was flowing, a fairly good vacuum was formed.



A simple water vacuum pump applicable for use in the laboratory where not too high a vacuum is required. It is a very interesting suggestion and applicable for many purposes as suggested in the article.

I experimented and found that if the spout was inserted about three feet from the end of the hose and the end allowed to hang down that the vacuum was greater. To get greatest efficiency, I stuck the stem in at an angle pointing to the outlet or nozzle end of the hose. This vacuum created is great enough to use in low pressure boiling experiments, and to aid in burning materials in a combustion tube in the chemical laboratory.

If some of the so-called "smoke-wood" of the boys is available, a piece may be inserted in the rubber vacuum tube and it will smoke quite nicely.

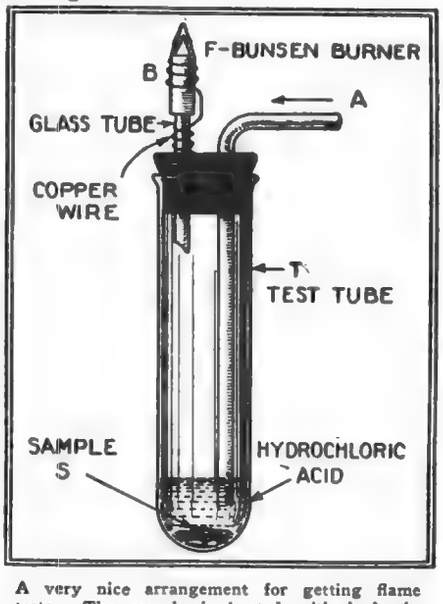
Syrup may be boiled rapidly without danger of burning if an air tight vessel with a spout is used and is connected with the vacuum arrangement.

Element Color Burner

BY DAVID B. FERRIERE

AN easily constructed spectrum burner is shown in the figure.

It consists of a test tube, T, with in and out tubes, and connected with the Bunsen burner, B, which is made from a glass tube and a pointed outlet tube connected together with a piece of copper wire as shown in the diagram.



A very nice arrangement for getting flame tests. The sample is heated with hydrochloric acid in the bottom of a test tube and the evolved vapor is led to an extemporized Bunsen burner.

Coal or water gas is led in through A and passes over the sample, S. The latter is moistened with hydrochloric acid. The test tube containing the sample is heated by a Bunsen burner.

This volatilizes enough of the chlorides of the metals in the substance, to cause the Bunsen flame, B, to assume the characteristic color of the element in the substance, or sample. Following are flame colors imparted by some elements:

Violet: Potassium salts.

Azure blue followed by green: Copper salts.

Yellow green: Barium salts.

Light blue: Lead, arsenic, selenium compounds.

Carmine: Lithium salts. Cannot be seen through green glass.

Scarlet: Strontium. Yellowish through green glass.

Yellowish red: Calcium. Green through green glass.

Yellow, dense: Sodium Blue cobalt, glass cuts sodium yellow off but allows potassium violet to be detected if present.

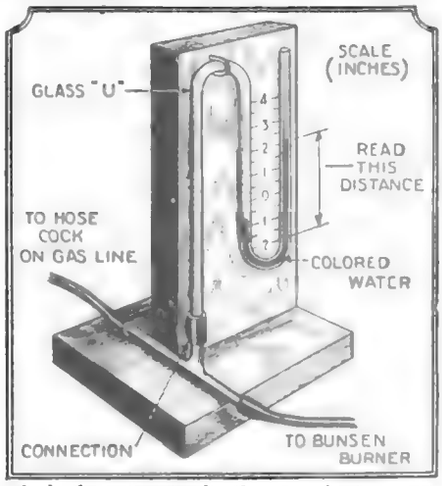
Useful Manometer

BY RAYMOND B. WAILES

IT is often necessary in a laboratory to reproduce a certain degree of heat. This manometer will tell the experimenter how much to open his gas cock so that the flame will be the same height as before.

The gauge is made from a length of glass tubing and a glass tee-tube. The drawing shows how it is assembled. The U section contains red ink, or water colored with a suitable dye. Colored chemical solutions can also be used.

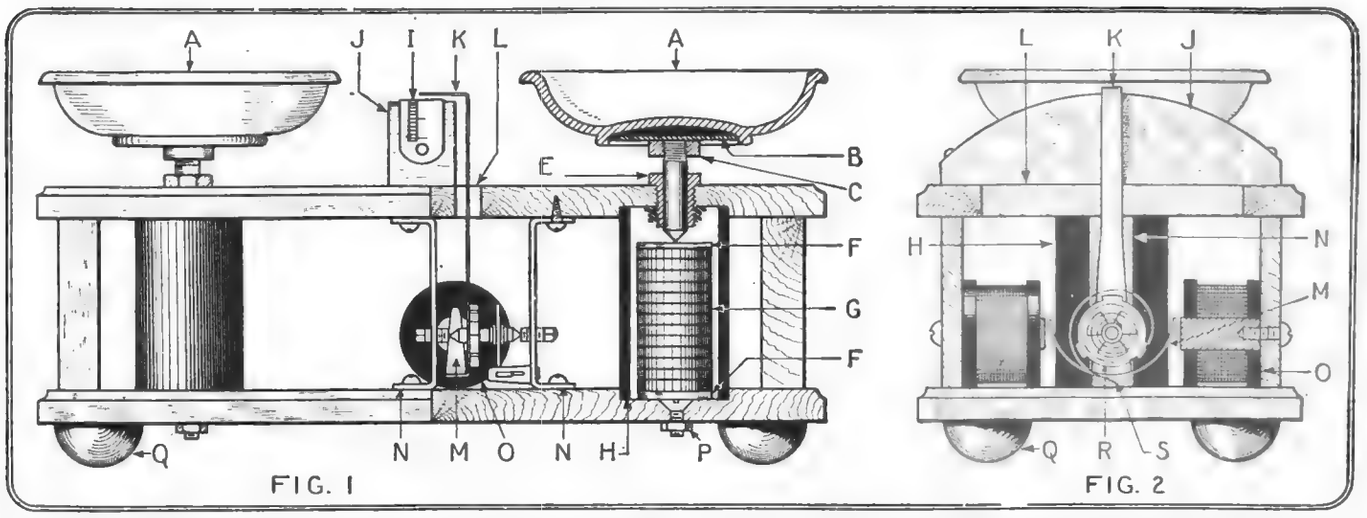
With the gas cock turned on full, perhaps a difference of the water levels would amount to one or two inches. By turning down the flame, the water level will drop. Say the experimenter found that a temperature of "one-half inch of water" was necessary to melt some kind of resin so that burning would not occur. Now in future cases when more of the same resin is to be melted, the gas cock should be turned down so that the pressurs is one-half inch of water. This will automatically produce very nearly the same temperature that was used in the last melting.



A simple manometer for the approximate regulation of gas-flame temperature.

A Precise Laboratory Resistance Balance

By PHILIPPE A. JUDD



Carbon disk rheostats are made the active element in a balance. The balance when constructed is available for use to weigh any substances within the range of its action. Each pan rests upon a pile of rheostat disks whose resistance increases as the weight diminishes.

A HOME-MADE balance of the usual type is in most cases a very fragile affair, and, at the best, none too reliable. The balance herein described was designed by the author to incorporate what he believes to be several new features; principles new in their application to the construction of scales. The result is a very reliable and substantial balance, which may be made supersensitive, by the addition of an amplifying unit.

The case is of hard wood and measures nine inches in length by four and one-half inches in width by two and three-quarter inches in height. There is a slot, three inches long by one-quarter inch wide, at the center of the top panel, to accommodate the pointer, K. A section of a wooden disk, five and one-half inches in diameter, is fastened along the edge of the slot. This disk-section, J, one inch in greatest width and four and one-quarter inches along its chord, carries a celluloid scale fastened to its upper surface, its arc. A semi-spherical rubber foot, Q, is provided at each corner of the base.

As the usual metallic scale pans, when used to weigh chemicals, soon become tarnished, and are exceedingly hard to keep clean, they have been replaced by porcelain pans. These are two evaporating dishes, three and one-half inches in diameter. They must be somewhat like those shown in the drawings, having a ridge around the under surface so that they will remain in place on the disk, B.

Instead of the usual lever arrangement, two piles of carbon disks are used to permit comparison of the weights in the pans. These two piles of carbon disks form two compression type rheostats which vary the current passing through them and the two magnets, O, O, as the weights in the scale pans are varied. When the weights are the same, the resistance will be of identical values, and, hence, the pointer will be held at the center of the scale, as the armature is attracted equally in either direction by the two magnetic fields.

The carbon disks are taken from compression rheostats, such as are used in radio circuits. Each pile must have the same number of disks. Contact is established with the carbon through copper or brass disks, F, F_1 at either end of each pile. The piles are inclosed in fibre tubes having an inside diameter slightly greater than that of the disks. A short length of quarter-inch brass rod, D, surmounted by the brass disk, B, carries the scale pan and transfers the weight to the carbon pile, upon which its lower,

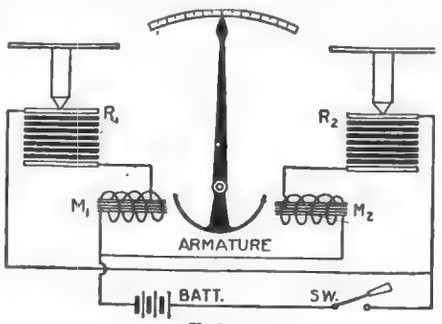


FIG. 3

Here is shown the scheme of connections for the resistance balance above described. A sort of galvanometer reads zero when the weights are equal.

pointed end rests, thereby varying the resistance of that side of the circuit. The brass bushings, E, E, are of the types used on radio panels and should fit the rod rather loosely.

The pointer and armature are cut from thin, tinned sheet iron, a piece from a tin can does very well; as shown in the detail, Fig. 2, and are bent on the dotted lines, as shown in the other drawings. This piece is then soldered to the pinion, which c[illegible] of the balance wheel, balance staf[f] spring taken from an old alarm whole is then mounted betwee[n] the two magnets as shown in Bearings are provided by th[e] which are cut from the clock frame, each strip carrying a recessed balance screw. After the free end of the hair spring has been made fast to the strip, N, the collet to which the other end is secured should be carefully moved around the shaft until the pointer rests, of its own accord, at the center of the scale, I. The magnets' axes must be concentric, and the pinion must be at the same height as and at right angles to this line.

The magnets may be taken from an electric bell, or may be constructed by the reader. In either case they should be as nearly identical as possible, particularly in regard to the number of turns of wire and its gauge, and the number of layers.

A flash-light battery and a push-button may be placed within the case, or an outside source of current and switch may be provided, as the builder desires. In the later case, two binding posts must be provided at the back of the case for connections. Fig. 3 shows the circuit used. All joints should be soldered. Where possible like leads in each circuit should be of the same length.

The instrument is used in the same manner in which other scales are used, the weight being placed in one pan and the material to be weighed in the other. The switch, must be closed when the balance is in use. If a closed circuit wet cell is used as a source of current, no switch will be necessary.

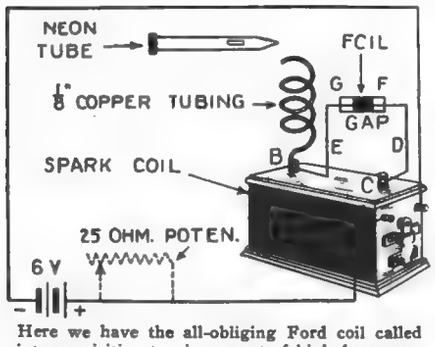
Ford Coil and Neon Tube Experiments

By STANLEY VAUGHAN

A discarded Ford coil is a good source of interesting experiments. The writer procured one for exactly nothing, which would still buzz. Some ⅛" copper tubing about five feet long is wound in a coil about four inches in diameter with the turns pulled wide apart. This is soldered at point B on the Ford coil. A six volt storage battery is connected as shown at points A and C. A 25-

ohm rheostat may be inserted to control the voltage. The neon tube is a spark plug tester made by the Westinghouse Lamp Co. When the coil is in operation the neon tube glows very brightly when held near to any of the center points of the copper tubing. Vertically through the center of the tubing the glow is medium. The neon glow can be detected when the neon tube is held at a distance of 2¾" from the copper coil.

If the extreme end of the tubing is open fine sparks about 1/32" long can be drawn



Here we have the all-obliging Ford coil called into requisition to give a sort of high frequency experiment. A Neon tube such as sold for automobiles is used to detect the excitation.

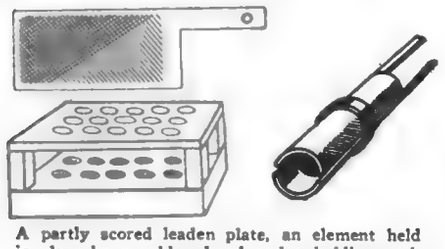
from the end and the glow is brightest at this point. A needle inserted at this end gives a slightly longer spark to the neon tube.

A No. 24 D. C. C. wire fastened at B and run for forty feet away from the coil still gives a faint glow even through the insulation. Two wires, D and E, connected as shown are placed inside a glass tube, leaving a short gap between. In doing this, it is a good idea to turn off the coil to avoid a shock. Next the apparatus is turned on and the neon tube is held against the glass at F. Only a slight glow is seen. At G, no glow is noticeable. However, if a small sheet of tinfoil is placed over the glass, a much brighter glow will appear.

Now if a solution of salt water is placed in a glass and wire D is put into this a small hot spark can be drawn if wire E is placed very near the top of the solution. The spark is a bright yellow which is the characteristic color of heated sodium vapor. It is best to use insulated wire in these experiments and also to turn off the juice when making changes.

A Simple B Battery

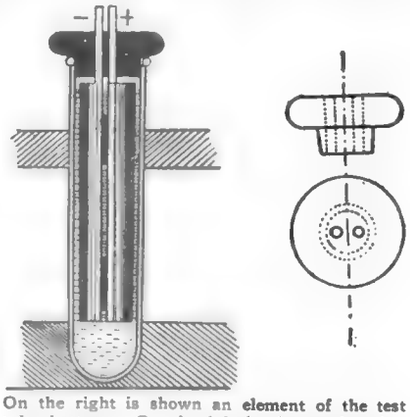
THE following simple B battery has been described by Hans Vatter in a recent German publication. The example given is a 40-volt B battery requiring twenty cells. The author uses test tubes one inch in diameter and five inches long for cells, and his lead plates are made of sheet lead 1-12th of an inch thick. The lead is cut in strips, a little less than one inch wide (2.3 cm.), and each plate has a lug or ear for its connection. The drawing shows everything.



A partly scored leaden plate, an element held in place by a rubber band and a holding rack for a test tube "B" battery which, however, may be used for various other purposes.

The plates now have to be roughened. They are placed on a flat surface and fine lines are drawn across them using a ruler and a sharp-pointed nail; these lines should be close together, sharp on the edges and rather deep. Care must be taken not to go through the plate. By two sets of these scratchings at an angle with each other the plate is divided up into a sort of little diamonds or dots. The closer these scratches can be made the better.

Each plate now has to be bent into a section of a cylinder, and to do this a wooden mandrel eight-tenths of an inch in diameter is used around which to bend the plates one by one or better two by two. This can all be done by hand. Forty pieces of such wood, or doweling must now be procured, each piece to be four-tenths of an inch long. These are to be boiled in melted paraffin, or at least heated to a high temperature therein. When thoroughly saturated, they are fished out of the paraffin and tried on a piece of paper. Forty India rubber bands are required now to grip the little plates, and as these must be only about four-tenths of an inch in diameter, they may be made by cutting sections from a piece of India rubber tubing. Two of the little disks of wood, one for the top and the other for the bottom, hold each pair of curved plates apart, and two India rubber bands are sprung around them, and we have our element. A stopper is made for each tube out of two pieces of wood put together as shown, with holes for the connecting strips to go through,



On the right is shown an element of the test tube battery. On the left is shown the plug which fits into the mouth of each tube.

two for each stopper, and this piece must be also heated in paraffin. As the connecting strips will not fit tightly, there is plenty of chance for the hydrogen to escape. They are filled with battery acid and the plates are formed in the regular way by successive charging and discharging giving what may be termed a little Planté battery.

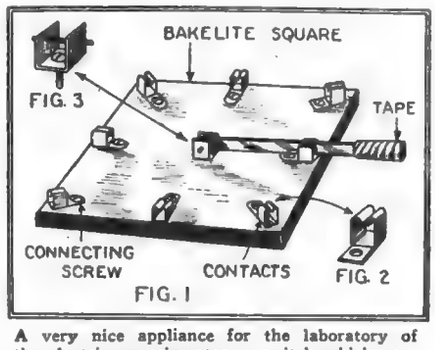
The Multipole Switch

By Harry Gilbert Smith, Jr.

THE size of the switch may be determined by the builder according to its use. The switch is designed when many instruments are to be used from the same source of current, eliminating many switches, but more than one instrument, of course, are not supposed to be running at the same time.

The block is a square of insulating material such as bakelite. Holes are drilled at each corner and at the center of each side to mount the contacts. The contacts are made from a small thin strip of copper, cut and bent as shown in figure; and mounted by means of a piece of tin soldered to the bottom of each, through which a hole to fit the mounting screw has been punched and reamed out. The mounting screw is also used for a binding post, to eliminate drilling extra holes. After connections are made, the contacts are adjusted to face the knife switch as shown.

In the center of the square a hole is drawn slightly larger than the screw to be used, so that the screw will pivot in the hole easily. The central contact or copper pivot (Fig. 3) is bent as shown, and a hole is drilled to fit the screw the head of which is soldered to the pivot; also holes are punched in each side of the pivot in order to fit a small brad (the head of which has been removed) which also runs through the knife switch, at the opposite end from handle; so that the knife will lift up and down easily. The knife is a strip of copper, and the handle may be made by a strip of ½-inch tape wound around the knife. But



A very nice appliance for the laboratory of the electric experimenter, a switch which connects to eight different terminals and which can be made to connect to as many more as desired.

remember one thing—the knife must be slightly longer than each corner, so that it will reach every contact.

All copper used in this is thin so that it is pliable, and holes may be drilled or punched in it.

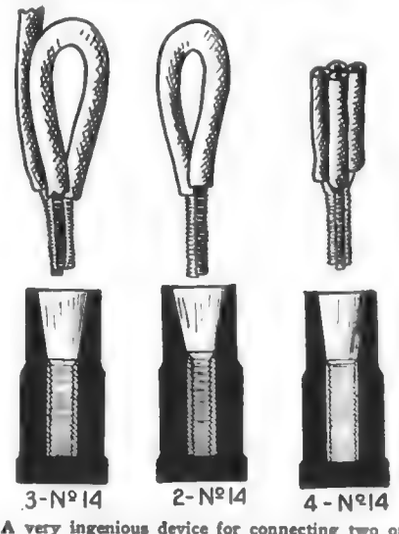
Wire Nut

THIS is a very simple contrivance for joining the ends of wires. It consists of a little case of insulating material of the cylindrical order, closed at one end, which is octagonal in order to give a grip, and the other end is drilled out with a conical opening leading to a brass female screw embedded in the material.

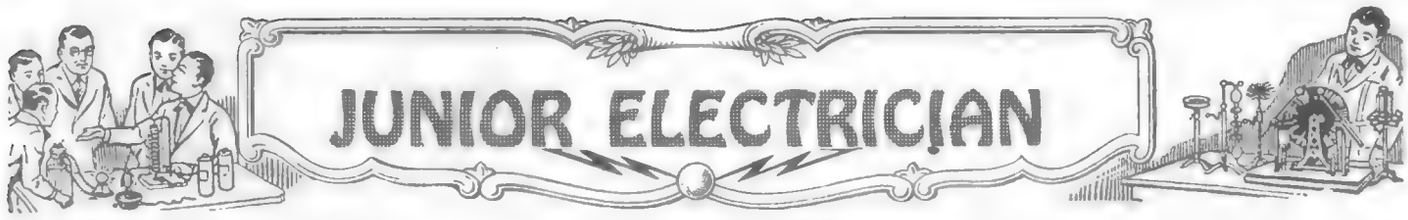
To connect wires, two or more of them as the case may be are laid together parallel, are pushed into the conical opening, and the wire nut is turned. The brass screw catches the wires, cuts a thread upon them as it draws them in, and jams them together, making a very good joint.

The nuts are made of different sizes and the sizes are marked upon them and the length of the octagon grip is also a clue to the size. The wires do not have to be twisted. If you have not got a small enough wire nut, an end of the wire may be bent over so as to give a greater diameter.

Further description is not needed.



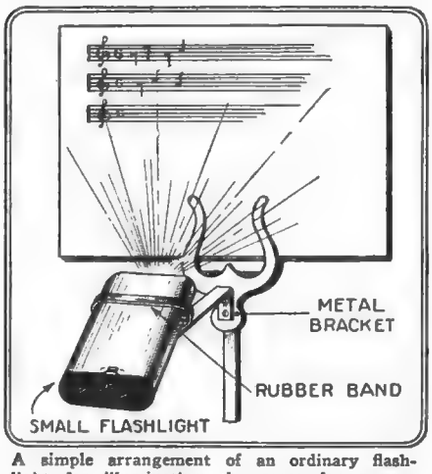
A very ingenious device for connecting two or more wires together. The wires are forced into the nut by screw action and becoming threaded thereby are retained firmly.



Electric Band Light

By Harold Jackson

A band is often called upon to play in poorly lighted places, evening concerts at the park, for instance, and the players often have difficulty in reading the notes of the music they are playing. This can be entirely overcome by the device shown in the accompanying sketch.



A simple arrangement of an ordinary flashlight for illuminating the score for a professional band to be used at night.

As shown, a small pocket flashlight is mounted on the music holder by means of a small bracket made of strap iron or brass. This metal bracket is soldered to the side of the flashlight and secured to the music holder either by soldering or by rivets. By soldering a loop to the music holder to hold the vertical part of the bracket, the flashlight could be easily removed when desired.

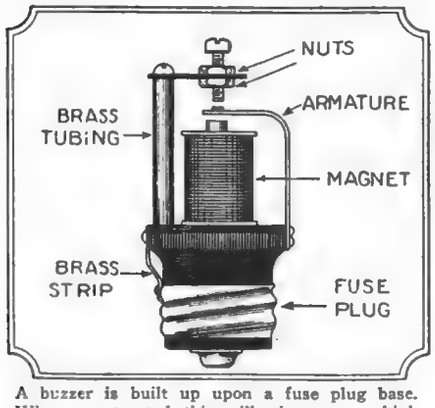
A stout rubber band is placed around the flashlight as shown, to hold the press button switch in contact.

High Pitch Buzzer

By G. R. Forbes

The drawing shows a buzzer giving a very high note, made with a fuse plug, so that it can be screwed into a base socket for use.

The cap and fuse wire are removed from



A buzzer is built up upon a fuse plug base. When constructed this will give a very high pitched note and may be used with different potentials according to the winding of the magnet.

the plug. Two small holes are drilled through the mica top—one in the center and one near the edge. A straight magnet is secured to the center hole, projecting upward. The standard to carry the vibrating armature is attached to the side hole. Care must be taken that the standard shall not touch the brass bushing around the cap of the plug. The magnet is made by winding No. 24 enamelled copper wire around a small flat-head bolt with fibre washers at each end. One end of the magnet winding is soldered to the regular contact on the bottom of the fuse, as indicated by the dotted line. The other end is soldered to the nut holding the standard. The cap-bushing, as we have called it, is connected to the screw of the plug by a soldered strip of brass.

A clock spring is used for an armature and a fillster head screw is made to serve as an adjustable contact and small nuts are soldered to the extending arm of the standard to hold it in place. The drawing makes everything clear.

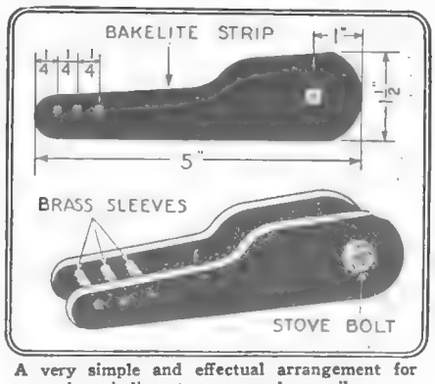
A Coil Taping Handle

By Lee Warren

Recently while taping some coils with cotton tape the work became very tiresome and with frequent annoying regularity I would drop my tape.

At length I thought up a little device for holding the tape. The materials for making it are two pieces of hard fibre, red or black, 5x1½ inches and a stove bolt 2¼x¼ inches, a short length of heavy copper wire and three brass sleeves each 1 inch long.

The pieces of fibre are sawed out as in the diagram. Two pieces are required, a hole



A very simple and effectual arrangement for properly winding tape around a coil, something which is not always well done.

is drilled 1 inch from the right hand end as shown and after these have been cut to shape and drilled, you must drill three holes about a quarter inch apart at the bottom (Fig. 1) of each piece of fibre.

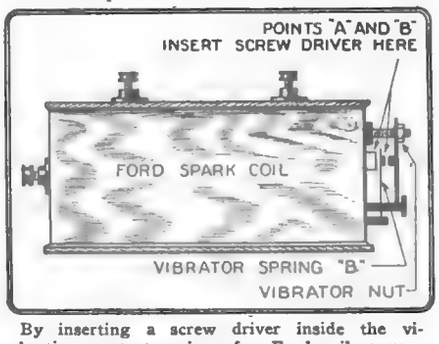
The copper wire is then cut into three pieces, each 1¼ inch long, the brass sleeves are slipped on the wires and they are put through the holes and riveted. The roll of tape is then put in the top end, the bolt slipped through and it is finished. Bring the ends out between the three brass sleeves as this regulates the unrolling of the tape. The wire and sleeves hold the two pieces of fibre at a fixed distance apart.

"Spark Coil Kink"

By F. R. Moore

For those who like electrical experiments calling for a spark coil with at least a ¼" spark, this kink will prove very useful. It is fairly well known that a Ford coil will at best give only a ⅜" spark, but we may obtain one of a greater length.

The vibrator is loosened so as to give a good spark and a piece of metal is inserted between the points, A and B. A screw driver serves nicely for this purpose, pressure against the end of the protruding iron wire core being made so that contact "B" is about ⅛" from the opposite one. This is readily determined by a little experimenting which when completed will cause an intense, noisy spark to jump across the gap. If desired, a piece of wood may be cut to fit snugly between A and B, leaving the hands free. One point to observe closely is this. Do not allow the metal part of the screw driver to short



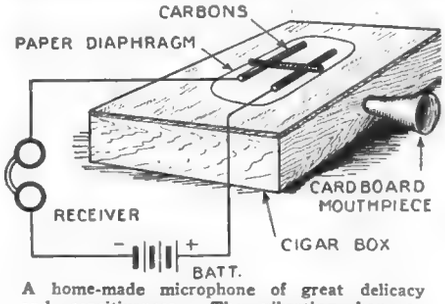
By inserting a screw driver inside the vibrating contact spring of a Ford coil, a very long spark will be produced.

circuit the coil, as this will damage the contacts and give unnecessary trouble. If the instructions given here are carefully followed the results will be entirely satisfactory. With a coil "fixed" as described, considerable work in high frequency can be done.

Sensitive Microphone

The illustrations show a modification of the familiar microphone which introduces the element of extreme sensitiveness. A hole is made in the top of a cardboard box whose length must exceed that of the carbons. To the side of the box a simple mouth-piece is fixed. It is evident now that in talking into the box the diaphragm which is made of thin paper will be thrown into vibration. Upon the paper diaphragm two carbon pencils are placed longitudinally as shown. These are connected in series with a battery and receiving telephone. A third carbon is laid loosely across the two parallel carbons, and the apparatus is complete.

If all has been properly arranged, the result will be surprisingly good from the standpoint of sensitiveness, because the least whisper will be magnified so as to give a



A home-made microphone of great delicacy and sensitiveness. The vibrating box on which it is mounted magnifies greatly the effect.

strong sound in the head-set or telephone. The receiver is supposed to be at a good distance from the microphone.

Slow Extinguishing Lamp Key

By Jacob Schmidt

The apparatus described here is intended to give, by the simple pull of a string, a light of a short duration, say one minute, at the end of which it extinguishes itself. The switch was designed and constructed by the writer for the use in a hall where light is wanted only for the short time necessary to ascend the stairs.

The parts necessary to construct the switch are as follows: An alarm clock (an old one will do), a metal bar an inch wide and ten inches long, two brass strips ten inches long,

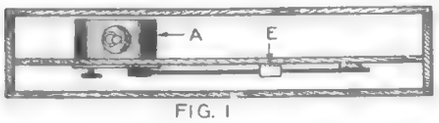


FIG. 1

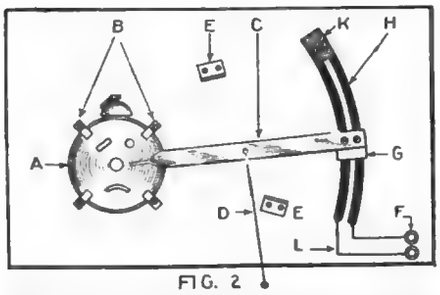


FIG. 2

The alarm clock again is called into requisition to give a slow extinguishing lamp key so that when the switch is turned off the lamp will burn for a short time.

a board 15 inches wide and 18 inches long and a few metal clamps. All dimensions are approximate—they may vary.

The escape wheel is removed from the clock so that the spring will slowly unwind, thus turning the winding handle or key, and it is upon this principle that the "slow extinguishing key" is based. On figure 1 it will be seen how things are arranged. A hole, slightly smaller than the alarm clock is made in the board. The clock is put in, face down, and fastened with clamps, B. One side of the metal bar, C, is bent so as to be easily fastened to the winding key. To the other side a brass plate, G, is riveted, preferably insulated from the bar by a leather strip, so as to make contact with the brass strips H. K is a piece of leather or other insulating material. E is a stop. D is a string by means of which the bar C is pulled downward. F represents the contacts. L represents the wires. The operation is as follows: Since the escape wheel is removed

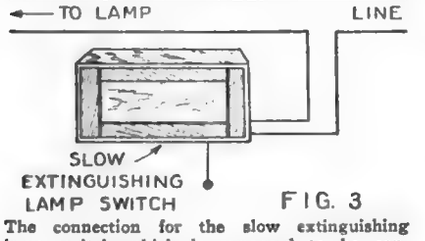


FIG. 3

The connection for the slow extinguishing lamp switch which is supposed to be contained within the box as shown.

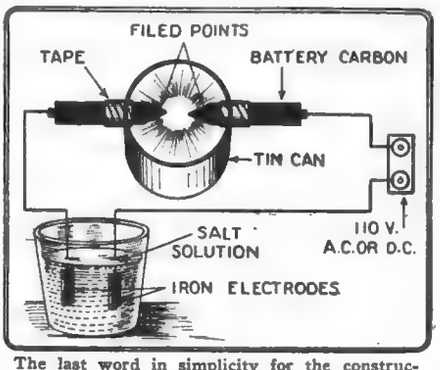
from the clock, the winding key will keep the bar C in the limit of upward motion, that is, the brass-piece, G, will be at K. When the string is pulled and the bar, C, goes down the brass pieces, H will be connected by G, and thus light the lamp. When the string is released the bar, C, will move slowly upward by the action of the unwinding spring, and until it reaches K, the lamp will burn, but the moment it reaches K, the circuit will again be broken and the lamp will be extinguished.

The whole board may be put into a cabinet as on fig. 3. Fig. 2 shows the top view.

Single Arc Lamp

By Fred Ehel

The last word in simplicity in the construction of an arc lamp is illustrated here. A tin can is used as a reflector and also to carry the carbons. Two holes are punched in the opposite sides and carbon electrodes which may be taken out of flashlight batteries pass through the holes. Insulating tape is wound around the carbon where they pass through the tin. This at once insulates them from the metal and insures a tight fit. The points may be filed or ground down on an emery wheel to make them start well.



The last word in simplicity for the construction of a reflexing arc lamp. A common tin can is the basis of the arrangement.

Ford Coil Photographic Flash Lamp

By S. J. Cinkus

The photograph which we reproduced shows a flash lamp for the use of the photographer for indoor work. The essential parts are a Ford coil, tin sauce-pan lid or plate or similar piece to hold the flash light

The spark from a Ford coil is used to ignite a photographic flashlight powder so that touching the switch will give the photographic exposure.

powder and a piece of stiff heavy wire. The lid must be connected to one of the secondary contact terminals of the coil, and the wire is soldered to the other. The primary of the coil is connected to a battery, a couple of dry cells are quite sufficient, and there is a switch in the line. On closing the switch, a spark passes between the end of the stiff wire and the lid, and ignites the flash light powder instantly.

This arrangement disposes of all danger and the cells will last indefinitely.

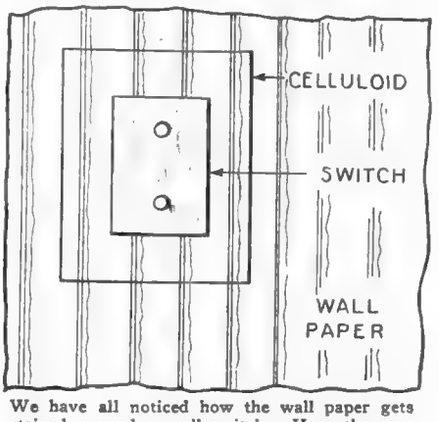
Wall Switch Shield

By Belgrave Gostin

The arrangement shown will do good service in protecting the wall-paper around a push button switch from getting dirty.

Cut a piece of celluloid 6 x 8 inches from an old car curtain and cut two holes near the center to correspond with the buttons of the switch, the plate may be used as a template, and put it on the switch under the plate.

When one reaches for the switch at night the celluloid protector will keep the hand from discoloring and rubbing the paper.



We have all noticed how the wall paper gets stained around a wall switch. Here the suggestion is carried out of putting a piece of transparent celluloid behind the plate so as to protect the paper perfectly.

Improved Daniel Cell

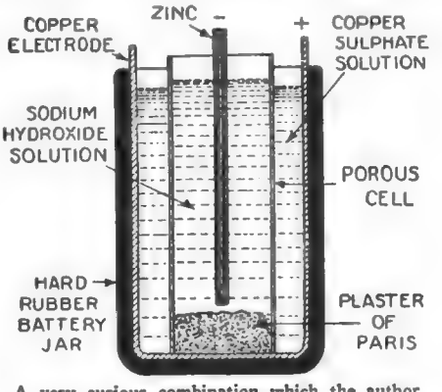
By David Terriere

The following is a description of a Daniel cell that when not in use does not deposit copper on the zinc as in the usual arrangement.

The container is a discarded hard rubber storage or starting battery-jar; these may usually be picked up at an automobile or battery service station for a few cents. The copper electrode is a flat sheet bent approximately U-shaped so as to fit down two opposite sides of the cell and across the bottom.

The zinc electrode is of sheet metal, inside of parchment wall constructed as follows:

A block of wood 1 inch wide, 4 inches long and as high as the battery jar. A piece of parchment, or thick brown paper if the cell is to be used only a few days, is cut to fit around the block with the edges overlapping about ½ inch; these are sewed together with thread and the holes are covered up or sealed with melted parafin wax. The cell is set on a flat surface and plaster of



A very curious combination which the author entitles a Daniel cell. The zinc is in a sodium hydroxide solution instead of the usual copper sulphate solution.

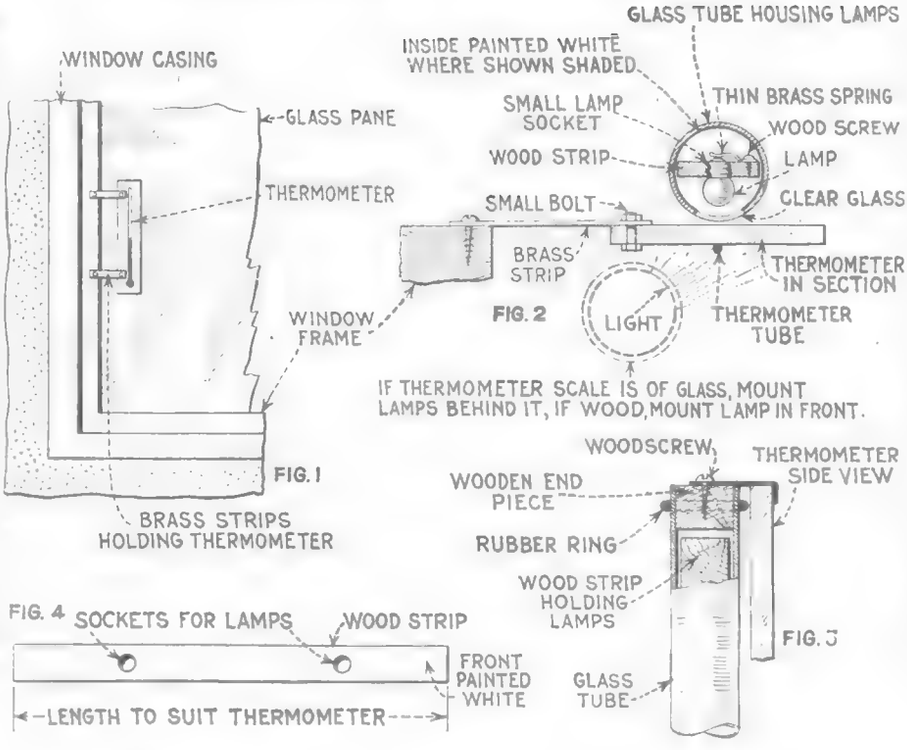
Paris poured in to the depth of 1 inch to form the bottom; when the plaster is dry and hard-set the cell is put between the legs of the copper plate, resting on the horizontal portion.

The solution in the copper compartment is a saturated solution of copper sulphate; the solution in the porous cell is a solution of 300 parts of sodium hydroxide in 1000 parts of water. By the use of sodium hydroxide instead of sulphuric acid, the diffusion of copper sulphate is prevented, and the E.M.F. is raised from 1.07 to 1.5 besides the consumption of zinc on open circuit is prevented.

THE CONSTRUCTOR

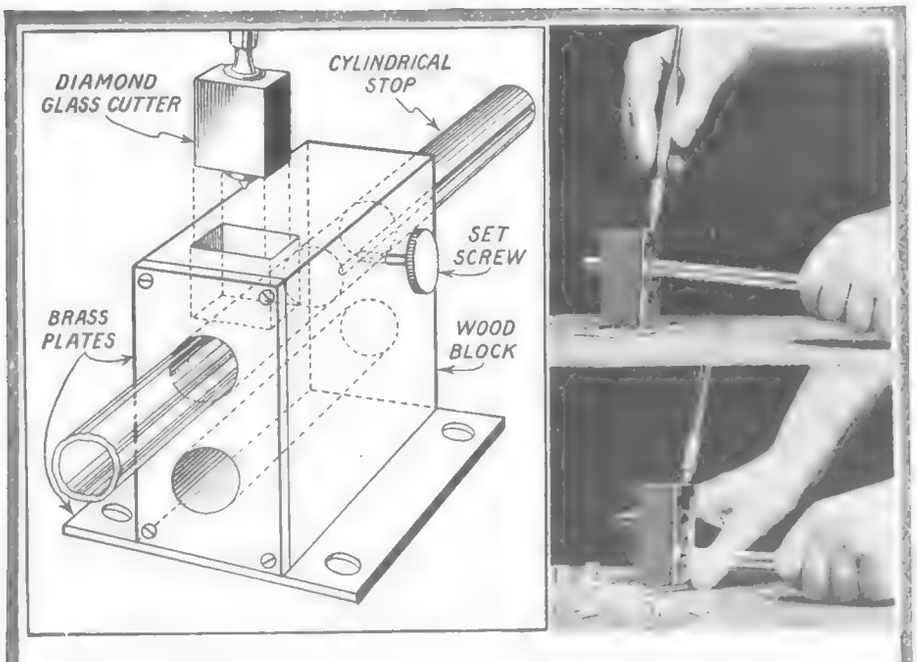
Illuminated Thermometer

It is often desirable to have a thermometer available which will indicate the temperature of the outside air and yet the average person, particularly during cold weather, does not desire to step outdoors in order to read such a thermometer. Even when placed near a window, all of the objections are not overcome because of the fact that, during the dark hours, the thermometer cannot be read without the necessity of some artificial light which, when placed on the opposite side of a pane of glass from a thermometer often causes a reflection that makes the reading of the thermometer impossible. A remedy for all these situations is illustrated at the immediate right.



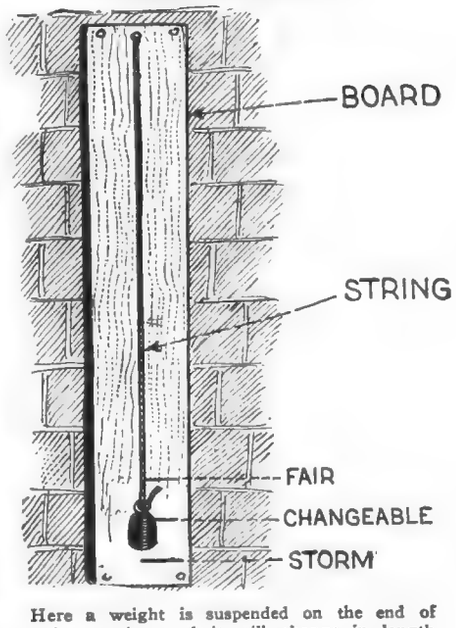
First, a thermometer suitable for exposure to the weather is obtained. This should be of a well made and accurate type. It is mounted on the side of a window casing by means of brass strips and then, a small electric light bulb is conveniently located to illuminate the instrument. In the particular case shown, a glass scale thermometer was employed whereupon the lamp housing was placed in back of it. If a wood or metal scale thermometer is used, place the lamp in front as shown in the dotted lines. In either event, details for the construction of the lamp housing are shown in the various diagrams at the left. They can be varied to suit the material at hand.—*C. A. Oldroyd, Rep. No.* 4433.

Glass Cutter



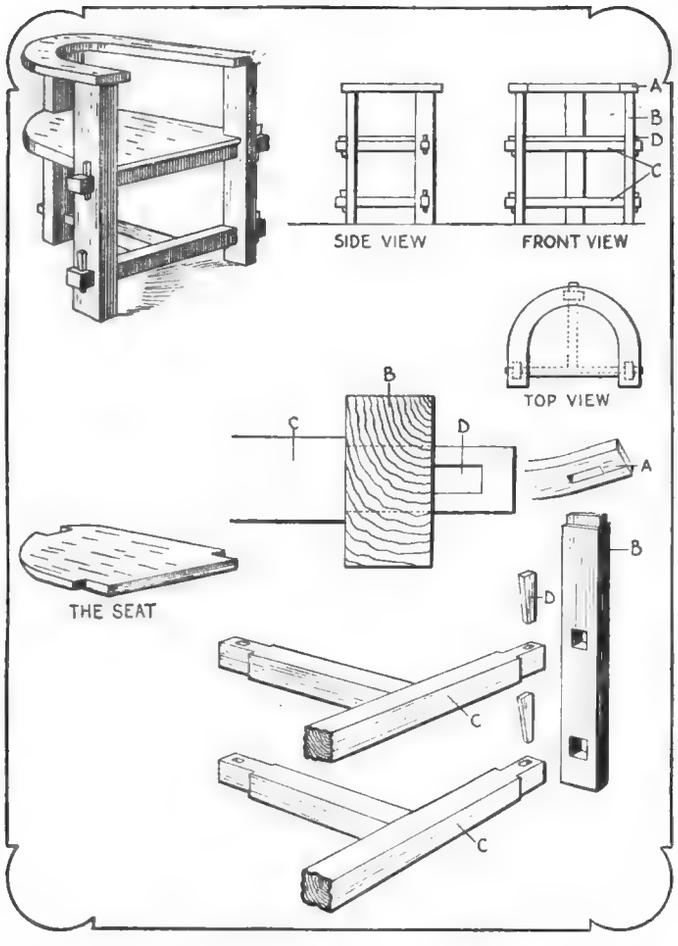
Where a quantity of glass tubes are to be cut to a predetermined length, the glass cutter illustrated above will prove invaluable. The construction is shown in the diagram at the left and the unit is in use in the illustration at the right above. The cylindrical stop determines the length of the tubes. In use, first scratch the glass in the top hole and then place in bottom hole and break off.—Author please send address.

Barometer



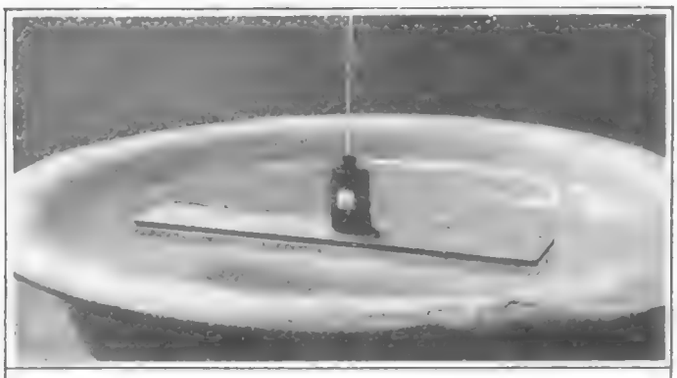
Here a weight is suspended on the end of a long string and it will change in length according to humidity. With a cat-gut string, the graduations will be in the order shown above but with an ordinary piece of cotton or hemp string, the order will be reversed. The location of the marks is to be determined after the device has been in use during different kinds of weather, the marks being made one on a fair day, one on a cloudy, damp day and one on a rainy day.

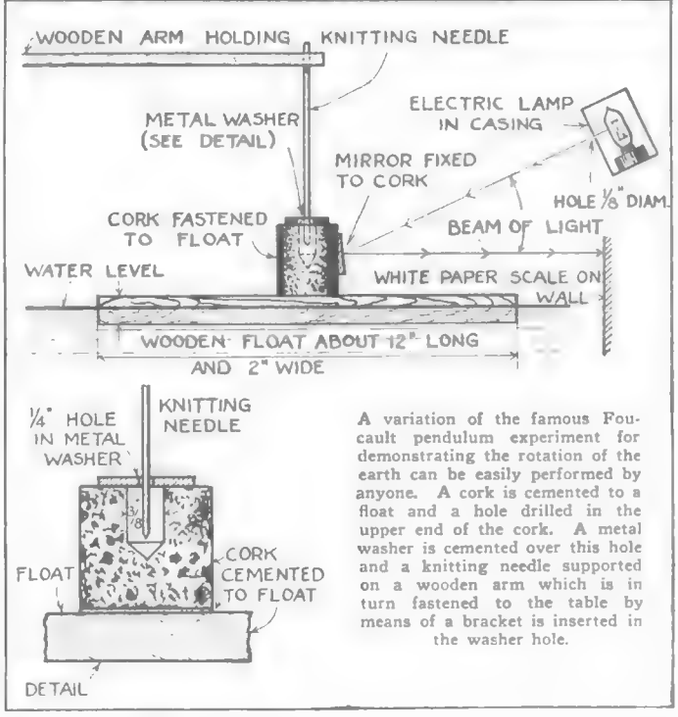
Nail-less Chair



The armchair shown in the illustrations above was originally designed in Vienna during the war and its unique construction was due to the extreme shortage of metals and glue at that time. It proved to be so practical and most important of all, so comfortable, that it has been adopted in many places as a standard office chair. Another point in its favor is that it can be taken apart or put together in a few moments and can be packed into a very small space. The figures shown are self-explanatory. The legs are pieces of 2" x 4" lumber 30" long. The depth of the seat is 16" and the width 22". The cross braces are 2" x 2". The arm rest is recessed so as to fit over tenons on the upper ends of the legs and is held in position by its weight. The seat rests on the two center cross pieces and is notched to fit around the legs.—Dr. Sidi Fischer.

Showing Earth's Rotation



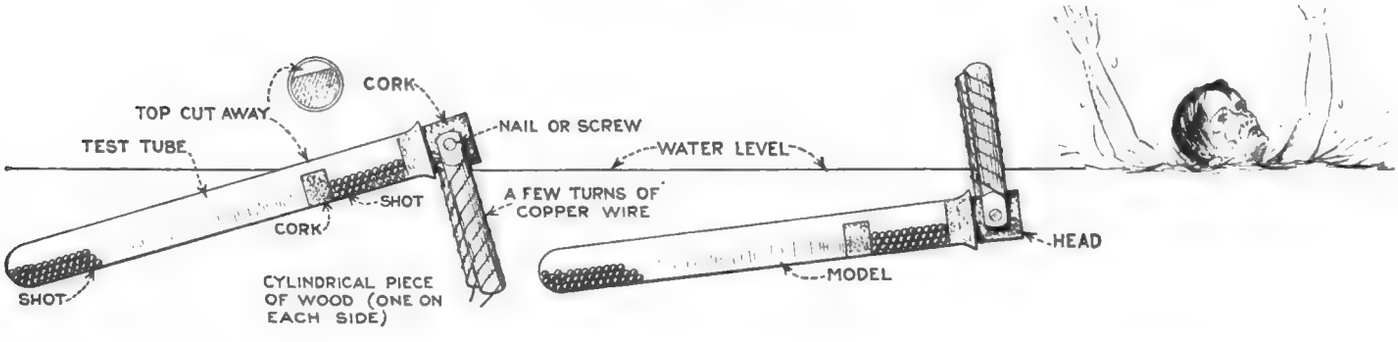


A variation of the famous Foucault pendulum experiment for demonstrating the rotation of the earth can be easily performed by anyone. A cork is cemented to a float and a hole drilled in the upper end of the cork. A metal washer is cemented over this hole and a knitting needle supported on a wooden arm which is in turn fastened to the table by means of a bracket is inserted in the washer hole.

A mirror is cemented to the cork and a beam of light directed upon it so that the reflected beam falls on a scale. Soon the beam of light will be found to move across the scale slowly because the earth and with it the basin has rotated, but the water in the center of the basin and consequently the cork has kept its original position.—C. A. Oldroyd, Rep. No. 4433.

Life Saving Demonstration

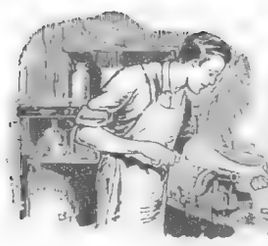
Mechanical Figure Shows Folly of Flinging the Arms Above Water When In Distress



HEAD ABOVE WATER WITH ARMS SUBMERGED
FIG. 1

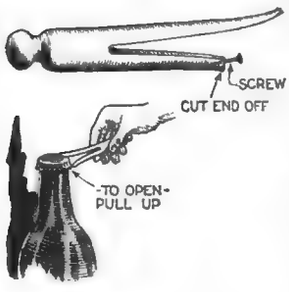
ARMS ABOVE WATER, HEAD SUBMERGED
FIG. 2

An experiment to show how a drowning person can keep his head above water if he will only keep his arms below water can be made with the apparatus shown above. The cylindrical pieces of wood representing the arms are balanced with a few turns of copper wire and the shot in the tube is divided between the two compartments until the apparatus floats as in Fig. 1. If, however, the arms are placed as in Fig. 2, the head sinks below the surface, indicating that a person in the water doing the same thing will force his head below water.—C. A. Oldroyd, Rep. No. 4433.



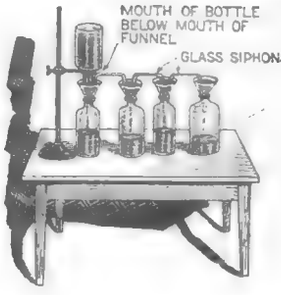
HOW TO MAKE IT

Bottle Opener



A clothespin is cut off as shown in the illustration at the left and a small screw driven into it. By placing the clothespin against the cap of a bottle as shown and pulling upward, the cap is easily removed. —Wilson G. Walters, Rep. No. 6385.

Rapid Filtering



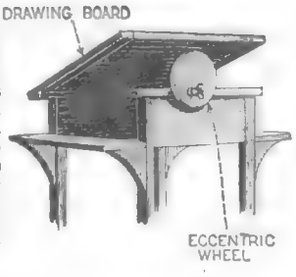
In order to expedite the filtering of a large quantity of liquid, the arrangement shown at the left may be used. Several filtering funnels are supplied with the liquid through the medium of small bent glass siphon tubes.—A. L. Inkpen.

Permanent Bubbles

Melt a quantity of resin over a low temperature flame. Dip a metal tube in it, blow, and a bubble will form. Blow quickly and cut off the bubble before it hardens. The opening will close and a permanent bubble results.—S. Leonard Bastin.

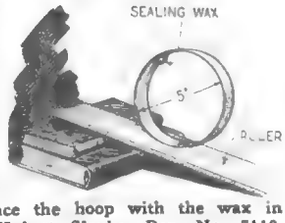
Tilting Drawing Board

A circular disk, eccentrically mounted, as at the right, will enable a draftsman to fix his drawing board at any desired angle. A thumbscrew on the end of the mounting bolt facilitates tightening. — Daniel Schofield.



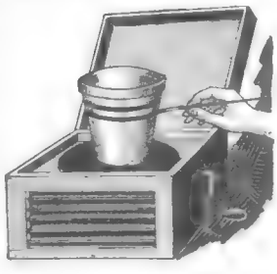
Anti-Gravitation

A seeming demonstration of anti-gravitation may be made as shown at the right. When properly placed, the paper hoop will roll up-hill. This happens because of the weight of the piece of sealing wax. Place the hoop with the wax in position shown.—Hubert Slouka, Rep. No. 7110.

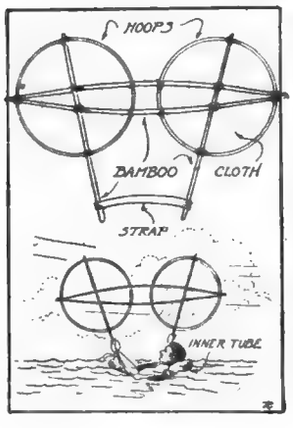


Trimming Flower Pots

To paint ring designs on flower pots and simlar round objects, place the pot on the turn-table of a phonograph, start it in rotation and hold the paint brush against the surface as shown at the right.—Peter Demergelis, Rep. No. 9902.

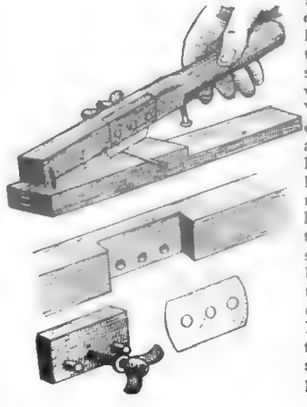


Sail for Swimmers



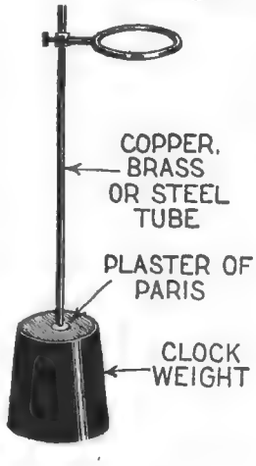
If several sails such as those illustrated at the left are made up, great sport can be had by staging races. The operators are supported by a partially inflated automobile inner tube and the sails, of the shape shown are held up so as to catch the wind. They are supported by a strap that goes across the chest.—L. B. Robbins.

Match Cutter



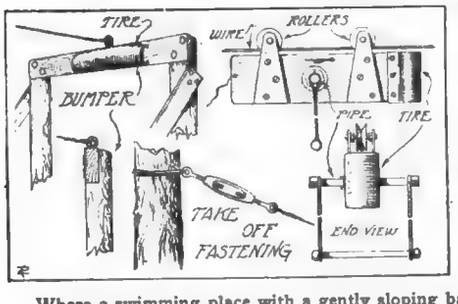
For those interested in our Matchcraft Contest, the device shown at the left will be of value. With it, matches can be cut to any desired length or the heads can be removed with the least possible trouble. An old safety razor blade furnishes the edge for the cutting process. It is clamped in the hinged frame shown. —Author please send address.

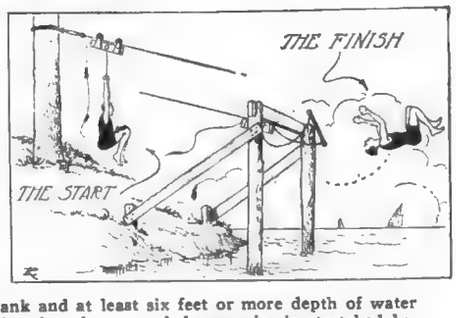
Ring Stand



An easily made ring stand for the laboratory is illustrated at the left. A metal tube or rod is placed upright in a clock weight or other heavy base and is held in position by plaster of Paris. A standard ring and clamp can then be fastened at any desired position. — F. R. Moore, Rep. No. 1993.

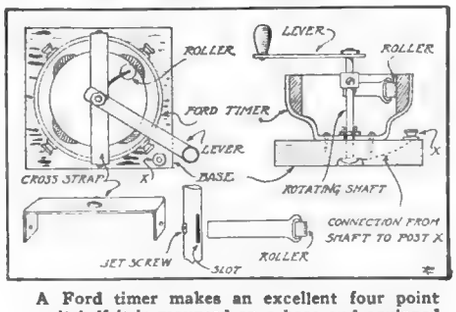
Swimmer's Slide





Where a swimming place with a gently sloping bank and at least six feet or more depth of water is available, the above illustrated slide will furnish a lot of sport. A heavy wire is stretched between a tree and the supports shown at the water's edge and a wheeled carrier is placed on this wire. A small trapeze is suspended from this carrier and the operation of the device is illustrated. Some interesting and thrilling dives can be performed. Be sure that the structure at the water's edge is amply strong.—L. B. Robbins.

Four Point Switch



A Ford timer makes an excellent four point switch if it is mounted on a base and equipped with a lever as shown directly above. The regular roller can be used for making the contact. Make connections to the binding post X and those on shell.—L. B. Robbins.

SCIENCE AND INVENTION desires to hear from its readers. It solicits comments of general scientific interest, and will appreciate opinions on science subjects. The arguments pro and con will be aired on this page. This magazine also relishes criticisms, and will present them in both palatable and unpalatable forms. So if you have anything to say, this is the place to say it. Please limit your letters to 500 words and address your letters to Editor—The Readers Forum, c/o Science and Invention Magazine, 53 Park Place, New York City.

MOVIE EXPOSES

Editor, SCIENCE AND INVENTION:

While it may be necessary to impart inside information regarding moving picture film productions, through the medium of magazines, I am of the opinion that SCIENCE AND INVENTION should discourage such a practice. The great success of moving pictures in these United States has been brought about because of the wonderful element of secrecy attached to the making of them. The public have become quite accustomed to movies and picture plays are a part and parcel of our daily life. Take from the film its one mystic element, the secrets of its actual making, and you will begin to tear down a structure that has been reared at the cost of millions of dollars. I have been noting with a feeling of misgiving the many articles that are gradually appearing disclosing, as it were, the many secret methods employed in the making of photo films. Few indeed did I consider would do much damage to the industry in general, but when I read and saw the photos published in the October SCIENCE AND INVENTION magazine, I began to fear for the future of moving pictures. The results of such a series of articles in a magazine of the importance and circulation of your publication will do more harm I am sure than can be realized at this time by the editor.

It may be true that the public mind is already used to the many arts and tricks employed in the moving picture industry. It may also be true that hundreds and thousands of workers in the films know its many secrets, but generally the one great magnet that has held an audience spellbound while seeing a thrilling scene or a series of impossible scenes, has been its mystic charm. Make the public fully aware that movies mean nothing but a series of fake films and the great moral lesson they teach will be lost and you will begin to notice the lack of public interest in all movies. I for one have never felt the least desire to go behind the scenes of a movie studio, although I have lived in California long enough to have been able to satisfy a curiosity had I wished to know how they are made. But like thousands, who I am sure will think as I do, I felt that a good photo-play was and is worth seeing, and I never did, and never will care what tricks were used to produce a good play.

Were we all to try to go behind the scenes of any theatre, where actual speaking plays are produced, and peer into dressing rooms, we would soon find no interest in plays. So I say in all sincerity, refrain from disclosing the secrets of film production. If you don't, you will surely rue the day, for the public are whimsical and can easily be turned against people and things. We have had our example of public sentiment changed over night. It would indeed be a calamity if this generation should turn against the movies. What we did without them has been forgotten, but what we would do without them now is a question few will dare to answer. They need popular support.

L. M. FISHER.
New York City.

(We do not believe that your statements to the effect that exposés, showing how trick moving pictures are made, tend to kill the value of the picture, are correct. The fact of the matter is that the moving picture producers as well as the authors of photo-plays are anxious for us to give them publicity on their pictures and are glad to supply us at all times with the details concerning the manner in which trick motion pictures are produced. You see when tricks of this nature are known to the movie fraternity, scenario writers as well as camermen and technicians must develop something new. Our modern motion pictures are nothing like what they used to be years ago because the art is constantly developing, and the further it develops the better will the movies be. The old tricks will constantly have to be improved upon; the good ones can be revamped and used in an entirely different manner, and on the whole the pictures will become more wonderful It is likewise interesting to see to what extent the producers will go in order to furnish a thrill. And why should the building of a gigantic theatre for the purpose of developing a play be completely ignored by the press, when more money was spent in erecting the structure and a greater amount of labor was expended on erecting the theatre or hall than in the actual taking of the pictures? The duplicatoin of Haddon Hall for the movie producers in this country is a typical illustration of the above statement. Our voting list shows that the majority of our readers like movie exposés.—EDITOR.)

CHEMICAL CLUB

Editor, SCIENCE AND INVENTION:

Just a few lines to let you know what I think of your splendid magazines SCIENCE AND INVENTION and THE EXPERIMENTER. I am only twelve years old and I want to say I agree with Samuel Thomas about "gambler's tricks." I think such matter looks out of place in your magazine.

There are some things I do not understand about SCIENCE AND INVENTION. Some of the jokes appear twice in it. I have seen jokes in late issues that were published some time ago and by the same author. I wish you would please explain this in Readers Forum.

I always have liked "Dr. Hackensaw's Secrets" and I sure missed it in the last issue. I think the serial now running by Ray Cummings is one of the best I have ever read. I have been reading SCIENCE AND INVENTION and THE EXPERIMENTER for the past two and a half years and I sure think there are no other magazines like them. I would like to see more chemistry articles in both. I have a laboratory of my own and I often experiment here.

I wish you could manage to start a chemical club for boys under fifteen years of age and have them exchange letters, experiments, experiences, etc. I have been interested in this kind of work for a long time. I am permitted to spend all of my spare time in a large dairy bacteriological laboratory and I take advantage of this. At our school we are organizing science clubs of all kinds and I will soon join the chemistry club.

JAMES H. BLACK,
Johnstown, Pa.

(We try to have our jokes in SCIENCE AND INVENTION magazine as original as possible, and our records do not show that any jokes have been published twice in this magazine.

With regard to forming a Chemical Club, we would inform you that we have given space in the Readers Forum for the discussion of such an idea before this, but it seems as though the majority of boys would rather have a chemical club of their own rather than a real national organization. The former idea may be considerably better than the idea of a national organization because the boys get together, discuss experiments and even demonstrate some of them. Incidentally the expense to each individual member of the club is quite small when the experiments are carried out by one of the boys every week, using the club's funds for the purpose of purchasing the needed chemicals and apparatus.—EDITOR.)

AMAZING STORIES

THE new scientific fiction magazine, AMAZING STORIES, will be on the newsstands April 10th. Here is a magazine after your own heart. Readers of this magazine who have read the scientific fiction stories for years will welcome AMAZING STORIES with open arms.

The new magazine contains only scientific fiction type stories and in the very first issue there is a story, "Off on a Comet," by the immortal Jules Verne, stories by H. G. Wells, George Allen England, G. Peyton Wertenbaker, and others from the pens of the foremost scientific fiction writers.

AMAZING STORIES has secured the sole rights to all of Jules Verne's stories, written by this, the greatest of all scientific fiction writers. All of these stories will appear in AMAZING STORIES.

Be sure to get your copy today.

The magazine is edited by Hugo Gernsback.

PRICE 25c PER COPY.

TELEPATHY

Editor, SCIENCE AND INVENTION:

Though I'm not from Missouri, I must be shown. According to your statement in the SCIENCE AND INVENTION for December, one can easily find a hidden object by noting the expression on the face of the person hiding the thing, or by noting a change in step or in breathing. Now don't you think that a person who would display such signs for so little a cause, would have a nervous system more sensitive than usual?

I have carried on a few minor experiments to see if a normal young man would display any such sign mentioned, and I have found that only one out of five even displayed interest in the search. Observing these experiments with me there was a young man known (locally) for his faculty of noting glances and the like. Then upon experimenting on those of the opposite sex, I found that only two out of five displayed even slight interest in the search. Perhaps though if the finding of the hidden object meant a great deal—I might say a very great deal—to them, they would gasp or change their expression. I am not arguing in favor of mental telepathy, for I am literally "on the fence" concerning the truth of any such phenomena, but I am saying that from my point of view, which I believe is logical, your statement is incorrect.

WALTER HELMSTADTER,
McKeesport, Penna.

(You have evidently not carried on your telepathic experiments to any great extent because there is among the magical fraternity a series of entertainers who permit any of their audience to hide an object of any nature, and then they walk around the room and find the concealed object. Sometimes this is done by what is known as muscle reading. Those well developed in this art hold the arm or wrist of the individual who hid the object. You stated that only one out of five were interested in the search when you used male subjects, and two of five were interested when you used female subjects. If our statements were incorrect you would have had no results whatever. There are, of course, a great many signs which you at the present time are not watching and for which you are not alert because you haven't analyzed or experimented with the system sufficiently.—EDITOR.)

DEFECTIVE IRON WATER PIPE

EDITOR SCIENCE & INVENTION:

On page 812 of your January issue, you showed a sketch that was supposed to explain the breaking of water mains. A little investigation on your part would have shown you your fallacy of this explanation.

In the first place, Cast Iron Pipe is bought by the TON, consequently, the manufacturer would have nothing to gain by making the middle portion of the pipe thinner than the ends. In case this is not clear to you, try to imagine how much more profit a butcher would make by selling you a pound of thin pork chops instead of thick ones, since his price per pound is the same.

Secondly: Each piece of pipe is weighed and the weight marked on it. As every size of pipe has a standard weight and this weight is known to the purchaser of the pipe, it would readily become apparent to him that the pipe was not up to standard if the weight were lower than the standard weight.

Thirdly: Each length of pipe is subjected to a hydrostatic test under a pressure greater than it will be called to withstand in service.

Any of these considerations by themselves should convince you that your explanation is absurd and the three combined should leave absolutely no doubt in your mind.

Will you kindly give this letter, or the ideas it contains, as much publicity as you gave the item that impelled me to write it.

THOMAS F. WOLFE,
Research Engineer.

(Your letter of some time ago read and contents noted in regard to the article on page 812 of the January SCIENCE & INVENTION Magazine, in which you take us to task for intimating that the manufacturer of the cast iron water pipe cheated the city by making the pipe thinner for the greater portion of each length.

We did not dream of this idea, but it is a matter of actual report from an engineer who saw this done quite some time back, and whose letters you will find in the files of the "New York Times."

The writer read this engineer's letters in the "New York Times" with great interest, and just as a matter of passing editorial notice, gave the clipping to our artist, Mr. Wall, as he thought the general reader would find it of some interest.

Of course, now since water and other iron pipe is bought by the ton or pound, as you state, there is no chance to put over anything like this and the hydrostatic test you also mention would of course, doubtless show up any weak pipe an unscrupulous manufacturer tried to palm off on the City Water Department.—EDITOR.)

JUST WHAT HE SAID

Editor, SCIENCE AND INVENTION:

I read your article in the September issue of SCIENCE AND INVENTION Magazine entitled, "Life Suspended in Ice," page 406, and wishing to convince myself I tried the following experiment.

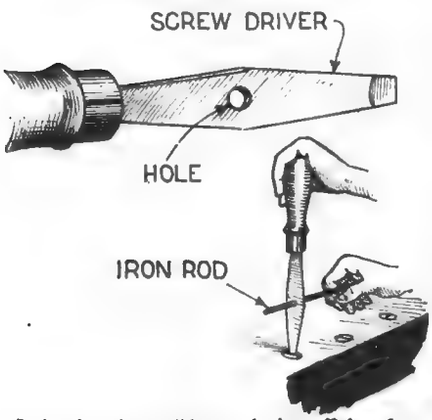
On the 9th of February I placed three gold fish in different dish pans out in the back yard. The following day when the water was frozen I took dish pan No. 1, broke the ice in it and likewise the gold fish to convince myself that it was frozen. I then took pan No. 2 and placed it under a cold water faucet and I let the fish thaw by water continuously running on the ice. Pan No. 3 was placed in a vessel of hot water and allowed to thaw.

(*Continued on page* 87)

WRINKLES
RECIPES & FORMULAS

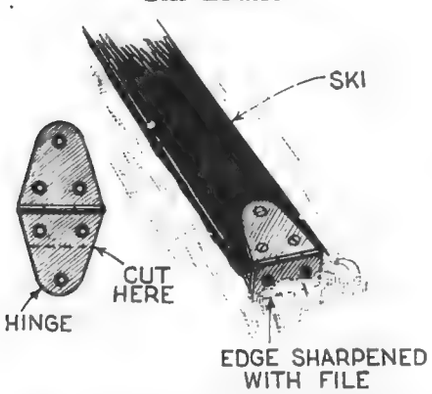
Edited by S. Gernsback

Screw Driver



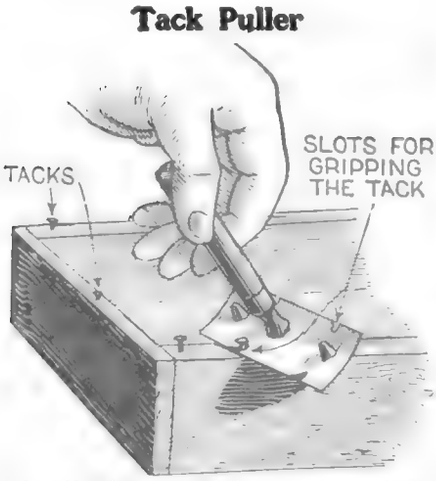
It is often impossible to obtain sufficient leverage with an ordinary screw driver, but if a hole is drilled in the blade as shown and an iron rod is used, this difficulty can be overcome. —Author please send address.

Ski Brake



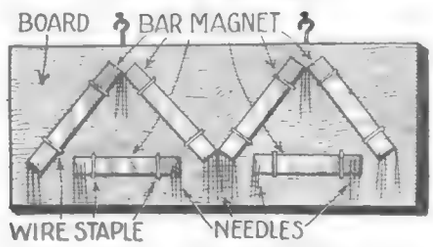
Attach a hinge to the rear end of each one of a pair of skis, after cutting one end of the hinge and sharpening the edge as shown. This will prevent the skis from sliding backward on an up slope.
—Author please send address.

Tack Puller



An old safety razor of the type shown above can be used as a tack puller by filing slots in the edge and using the device in the manner shown.—Peter Helmers, Rep. No. 27,434.

Needle Holder



Where needles or other steel objects are frequently employed, they are often mislaid. If, however, several bar magnets are fastened to a board as shown above, the needles can be placed against the magnets and they will be held in position until wanted. By using different shapes and sizes of magnets, decorative patterns can be made.
—Ivy M. Howard, Rep. No. 19,697.

MAGIC WIRE FLY SCREENS

The ordinary wire screens for doors and windows offer no protection from prying eyes. This can be remedied by giving the outside of all screens a coat of thin white paint. Strange as it may seem, the paint will not be noticeable, and, while those inside the house may look through the screen the same as before, outsiders cannot see into the room. The paint should be made as thin as possible with turpentine, and applied with a broad, flat brush.

ICELESS ICE

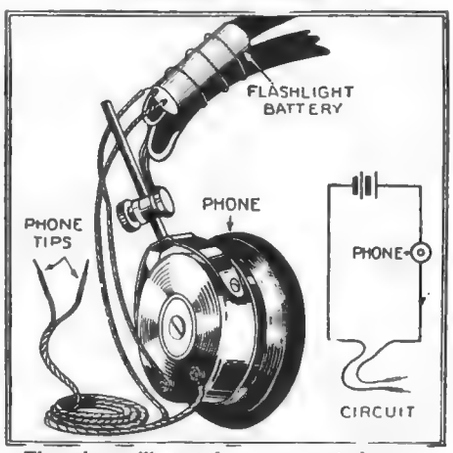
Place the articles to be frozen or kept cool in an earthen jar, place this jar in another larger jar so as to leave a space between the two jars and at the bottom. This space you fill with the following mixture: Sal Ammoniac, 10 ozs.; saltpetre, 10 ozs.; sodium sulphate, 1 lb. Mix in a quart of water and use immediately. Cover both jars until the cream, or whatever you have in the jar, is frozen or as long as you want the articles to be kept cool.

VICTOR R. PAYTON.

Cleaning Silver

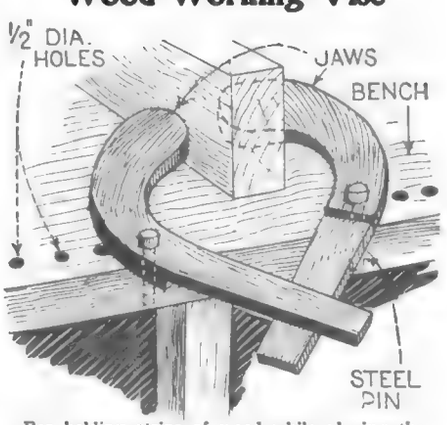
If stained and tarnished silverware is placed in sour milk and allowed to remain there for about 30 minutes, it can be washed and rinsed in the usual way and it will be found that practically all of the stains have disappeared. The lactic acid in the milk does the work.
—Mrs. Nina Jeffers.

Circuit Tester



The above illustrated arrangement is very handy for testing apparatus for open circuits. The cord tips are touched to the suspected instrument terminals.
—Author please send address.

Wood Working Vise

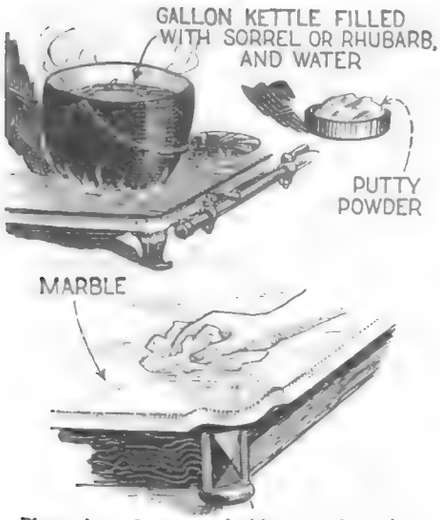


For holding strips of wood while planing the edges the above illustrated clamp will prove valuable. It is made of two pieces of wood shaped as shown and pinned to the work bench. Plane toward the edge of the bench as shown. —F. J. Wilhelm.

Flower Garden

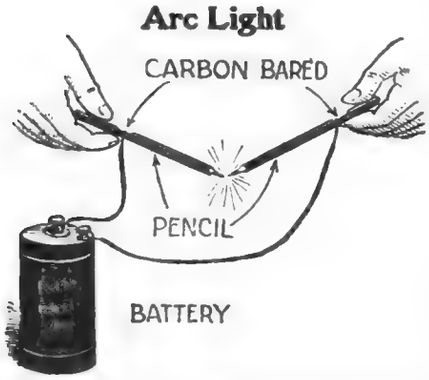
An old automobile tire makes an excellent rim for a flower garden. It holds the earth in place and at the same time is decorative.
—Author please send address.

Polishing Marble



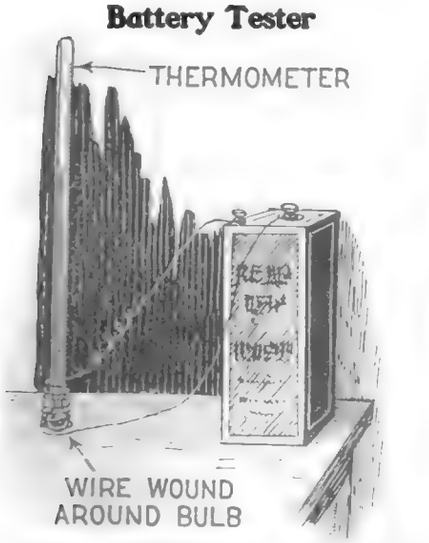
Place about 2 quarts of either sorrel or rhubarb in a kettle, add 2 quarts of water and boil hard for about 20 minutes. Bottle the liquid, cork and allow to stand for a week. To polish marble, mix some of the liquid with putty powder and apply with a cloth.
—August Jeffers, Rep. No. 26,973.

Arc Light



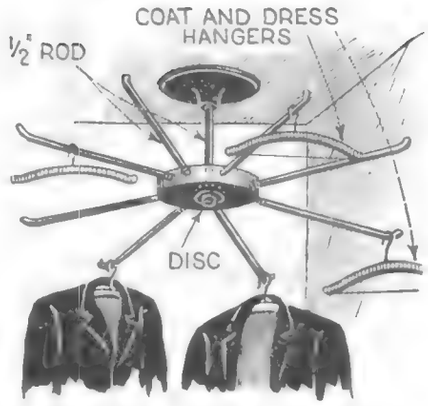
Two ordinary lead pencils make an excellent, yet simple arc light. The carbon centers are bared and wires wrapped around them. Touching the points together as above, forms a small arc.
—Comrade Ruppert, Rep. No. 18,566.

Battery Tester



With the arrangement shown above, having a 10-ohm resistance around the thermometer bulb, a tester for low voltage cells and batteries can be made. It can be calibrated from a standard ammeter.
—F. R. Moore, Rep. No. 1,993.

Clothes Hanger



To increase the convenience of a closet, a rotary clothes hanger such as that illustrated in detail above can be installed. The entire arrangement can be made from pipe fittings and iron rods. The ends of the rods supporting the clothes hangers are to be curved upward so as to prevent the hooks from sliding off. With this arrangement, any desired garment can be easily found by rotating the rack.
—F. J. Wilhelm.

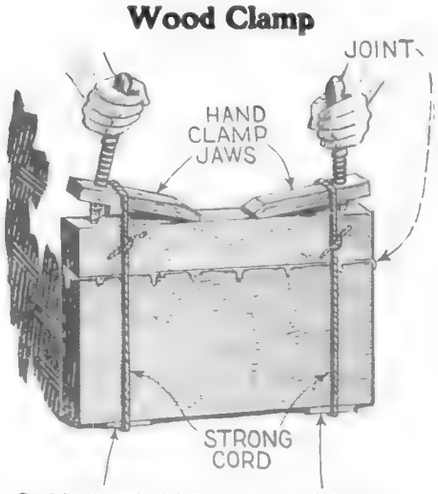
SILVER GRAY WOOD STAIN

This is very good for decorating radio cabinets, wooden objects, etc. Put one part of pyrogallic acid in 25 parts of warm water and coat the wood with this. Allow this coating to dry and meanwhile, prepare a solution of 2 parts of green vitriol in 50 parts of boiling water with which the first coating is covered to obtain the silver gray shade.
Roy Ruch,
Reporter No. 26599.

SPIRIT WRITING TRICK

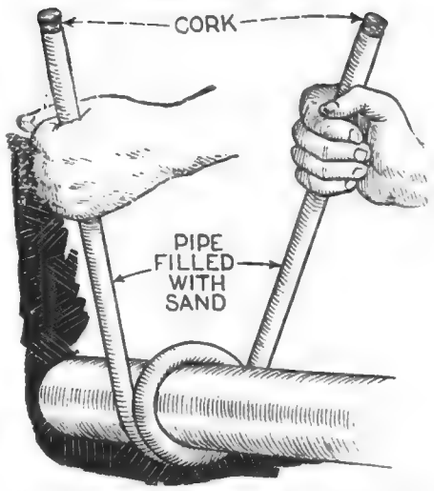
Dissolve 40 parts of saltpeter and 20 parts of gum arabic in 40 parts of warm water. Write or draw pictures on white paper with this solution using a common pen. All the lines must connect, however, and one of them, must run to the edge of the paper, where it is to be marked with a pencil. When a burning match is held to the marked spot the line begins to glow, and spreads quickly all over the writing or design, making the formerly invisible design appear signed. This is a simple little trick and perfectly safe.

Wood Clamp



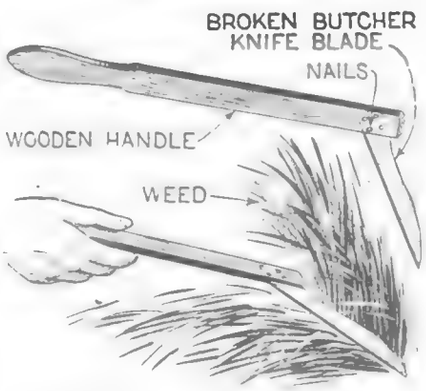
When gluing the edges of boards together when no cabinet maker's clamp is at hand, you can use some strong cord and a hand clamp. Take the clamp apart and use the two halves of it in connection with two pieces of cord as shown in the above illustration. Be sure that the knots in the cord are tight.
—Thomas Reed.

Bending Pipe



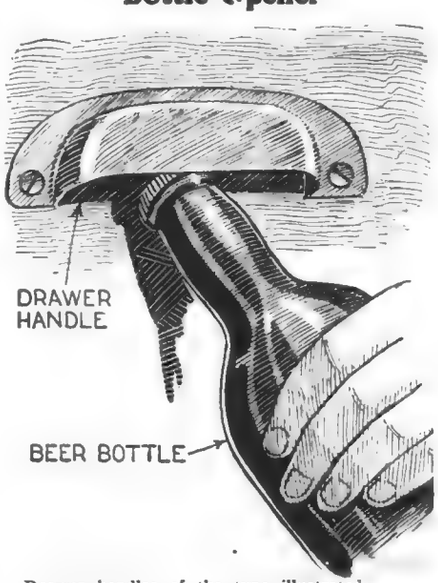
To bend pipe evenly, fill it with sand and cork the ends. The pipe can then be easily bent without fear of collapsing. Another way is to use melted resin or tar to fill the pipe but this is more troublesome.
—Albert Staehle.

Grass Cutter

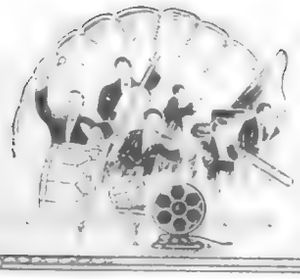


A simple knife for cutting weeds can be made by fastening an old butcher knife blade to a wooden handle and manipulating the finished product as shown in the above illustration.
—Ivy M. Howard, Rep. No. 19,697.

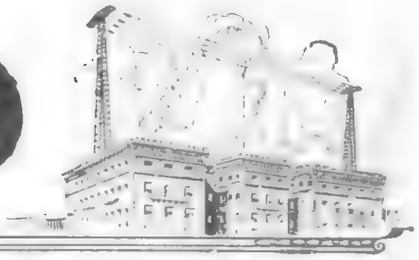
Bottle Opener



Drawer handles of the type illustrated make an excellent bottle opener for crown caps. Insert the cap as shown and press downward.
—Albert

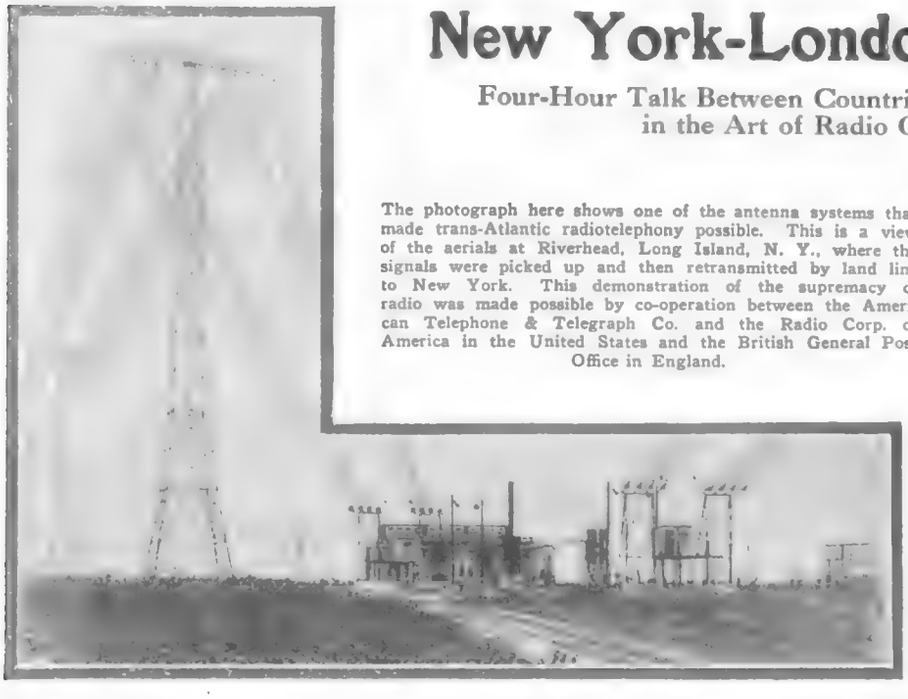


RADIO



New York-London Radiophone

Four-Hour Talk Between Countries Establishes a New Epoch in the Art of Radio Communication



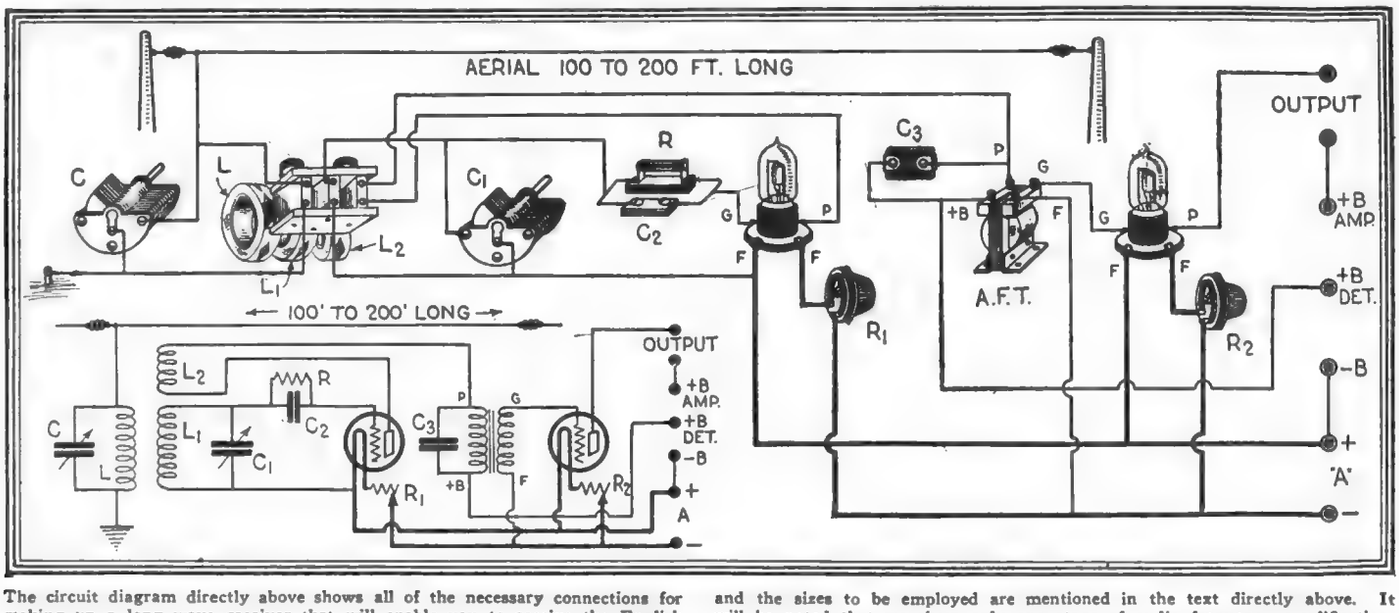
The photograph here shows one of the antenna systems that made trans-Atlantic radiotelephony possible. This is a view of the aerials at Riverhead, Long Island, N. Y., where the signals were picked up and then retransmitted by land line to New York. This demonstration of the supremacy of radio was made possible by co-operation between the American Telephone & Telegraph Co. and the Radio Corp. of America in the United States and the British General Post Office in England.

ALTHOUGH trans-Atlantic telephony has been accomplished in the past, notably when in 1915, communication was established between Arlington, Va., and Paris, France, still it has only been recently that really effective two-way communication has been carried on with any great degree of consistency. Tests are now being carried on at regular intervals and by tuning a receiver to the transmitter wavelength, namely 5,800 meters for the American transmitter and 6,200 for the English transmitter, some interesting radiophone speech can often be picked up. In order to aid you in this work, we are illustrating at the bottom of this page, a very simple type of vacuum tube receiver that is capable of being tuned to the high waves mentioned and that will operate very effectively. The constants of this circuit are as follows:

The primary or antenna circuit is tuned by means of a condenser and an inductance connected in parallel. They are indicated by C and L and the condenser C has a capacity of .0005 mf. The inductance L is a 500-turn honeycomb coil and it is placed in a three-coil mounting with the other two inductances L1 and L2. These two coils constitute the secondary and tickler respectively and L1 is a 500-turn coil, whereas L2 is of the 300-turn size. L1 is tuned by a parallel condenser C1 of .001-mf. capacity. C2 is a standard grid condenser with a capacity of .00025 mf. and R is its accompanying grid leak which may be variable or may have a fixed value of 2 megohms. C3 is a fixed condenser of .001-mf. capacity. R1 and R2 are standard rheostats of the size necessary to control the particular tubes used. Any of the standard tubes, either dry cell or storage battery operated can be employed in a receiver of this nature. This set is tuned in the same way as a standard three-circuit tuner.

Aside from the experimental radiophone transmission that can be picked up on the long waves tuned in by this receiver, you will get an excellent chance to practice code reception. A good many of the commercial stations operating on the higher wave-lengths transmit press and other material at a speed of 10 to 15 words per minute. Tune in on some of this and try your hand at code reception.

In the trans-Atlantic radiophone test, a new system of so-called side band transmission is employed and it is said that in order to get the very best results, a local external oscillator should be used even with an oscillating type of receiver. However, in actual practice it has been found that the difference in results obtained with the receiver illustrated below and one employing an oscillator does not compensate for the additional apparatus necessary for building the oscillator.



The circuit diagram directly above shows all of the necessary connections for making up a long wave receiver that will enable you to receive the English and American broadcasting on 6,200 meters and 5,800 meters respectively. Because of their compactness, honeycomb coils are used for the inductances and the sizes to be employed are mentioned in the text directly above. It will be noted that we show only one stage of audio frequency amplification. More may of course be added, but with head-phones, good reception can be obtained with the two tubes shown.

Problems of a Radio Program Director

By CHAS. D. ISAACSON, Program Director, WRNY

HELENE KOSTER
Mezzo - Soprano, who appears at WRNY in the Light Opera Periods.

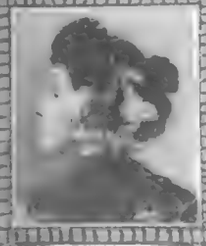
VICTOR WITTGENSTEIN
Well-known Pianist, who gave a recital over WRNY in advance of his new tour.

ISABELLE AUSTIN
Formerly of Roxy's Capitol Theatre Ensemble, who appears often at WRNY.

NORMAN SECON
Concert Pianist, who is a regular feature on WRNY programs.

SYLVIA RITTENBERG
Young debutante singer who is frequently heard over WRNY.

CAV. A. SEISMIT DODA
Famous vocal master and composer, who directs members of his studio in WRNY programs.



MARJORIE STUART
Who appears with a program of Oriental songs at WRNY on alternate Fridays.

RICHARD HAGEMAN
One of the greatest of American opera conductors, who directs a musical period at WRNY.

I WONDER if you folks who listen to the radio ever think about the program director—what he is trying to do? And what are some of his problems and handicaps and advantages?

The program director must sense instinctively what you listeners want to hear, and something more than that too, perhaps: what you should hear, what is good for you to hear, and what other people want to hear, who are right next door to you, and tuning in at the same time as you are.

Every station is governed by certain limitations. For instance, a program director in a little town can use only the available material. But in New York City, which is the gathering-place of the great in music, the stage, literature, arts, and every walk of life—they are all here. Take them if you can get them, but who, what, when, how?

Some program directors, very naturally and logically, turn entirely to jazz entertainment. That is all that they think of, that is all that they want, that is all that they try to bring to the listeners—and they have listeners a-plenty. But some program directors—and the writer of these articles is one of them, feel that the public wants something more than the utterly jazz type of entertainment, at least part of the time. In fact, over at WRNY, we are strongly of the opinion that the kind of people we would like to reach and please, want their diet of entertainment so balanced that jazz and the purely frivolous occupy only a minor part of the menu.

THE EASIEST WAY—AND THE OTHER

There is very little for the program director to do in putting on a jazz program. There is dance music, popular singers, some more dance music, another group of popular singers, and there it is! One thing is as good as another, all things being equal, and you turn the wheel and grind it out like a string of hamburger steak. But the moment that the program director seeks to vary his program, to supply a rounded-out bill, then come his problems.

How far can he go in seeking concert music, how high a standard may he set, how

(*Continued on page 74*)

THE UNION CITY FOUR
This banjo and mandolin ensemble is heard frequently from WRNY in medleys of popular songs—especially in the DX hours for our distant friends who listen in late.

H. O. OSGOOD
The voice of "Musical Courier Says —" who is heard twice a week over WRNY in interesting talks.

JUDITH ROTH
One of the finest of the regular singers over the microphone of whom we know, a WRNY feature.

HERBERT SOMAN
Conductor of the Orlando Roosevelt Concert Orchestra, which you hear three times a week over WRNY.

MAUDE MORGAN
Who has appeared before nearly all Europe's royalty in half a century on the concert stage.

GORDON HAMPSON
Pianist and Composer, who conducts a light opera series at WRNY.

BETTY LANG
Singer of popular songs to her own accompaniment, a regular WRNY number.

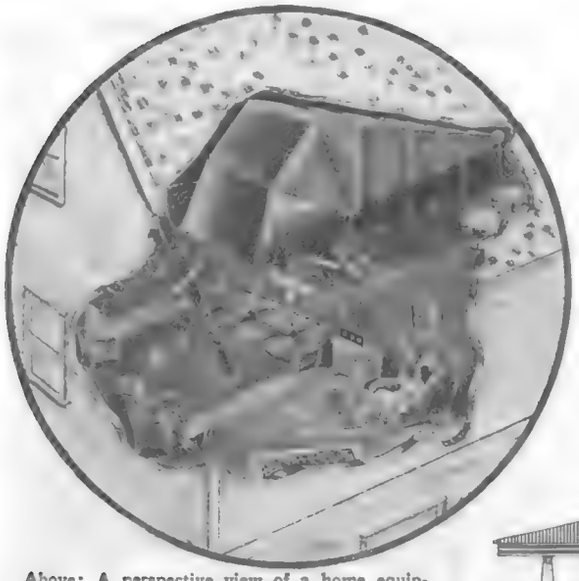
GRETA MASSON
American Soprano, a great success at WRNY, will be heard again in Sunday night concerts.

LOUIS RICHLING
A baritone of many concert engagements, who is heard regularly over WRNY.

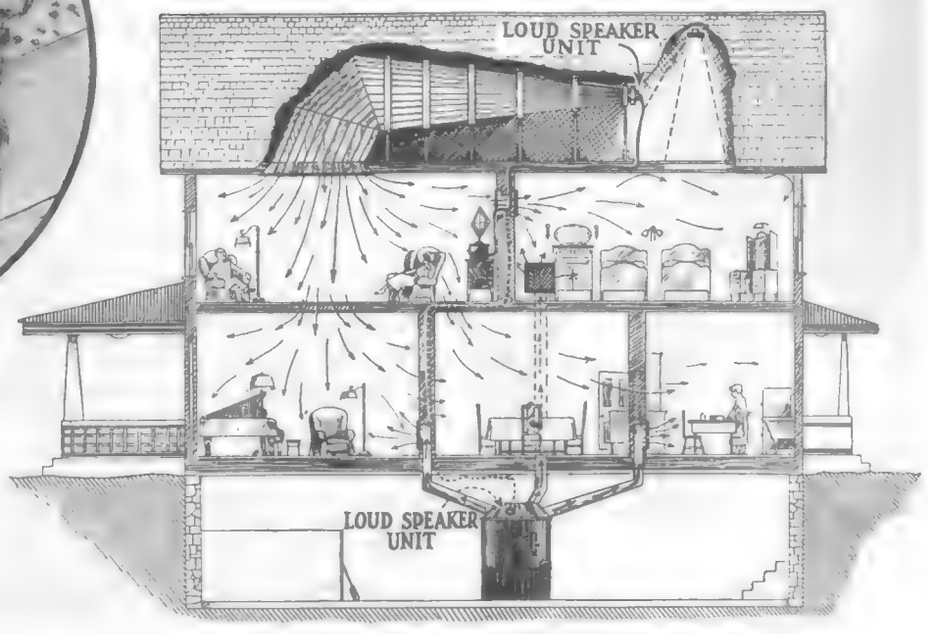
The Loud Speaker Problem

Some Interesting Data on the Best Types of Loud Speaker Horns

By H. WINFIELD SECOR



Above: A perspective view of a home equipped with an ideal loud speaker employing a 20-foot tapered horn.

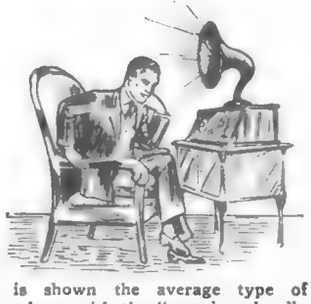


Above: Three suggestions for the experimenter with loud speakers. One very long loud speaker horn is shown extending through part of the length of the attic. Another compromise type is shown in dotted lines directly to the right of the long speaker and the third suggestion is the incorporation of a loud speaker unit in the hot air furnace, preferably in the cold air intake.

WE have been so used to the usual types of loud speaker horns that are to be found in the various radio stores today that the exact shapes and sizes of them are no longer given very much thought. However, Prof. Dayton C. Miller, of the Case School of Applied Science, Cleveland, O., recently gave some very interesting sidelights on this work. In part he said:

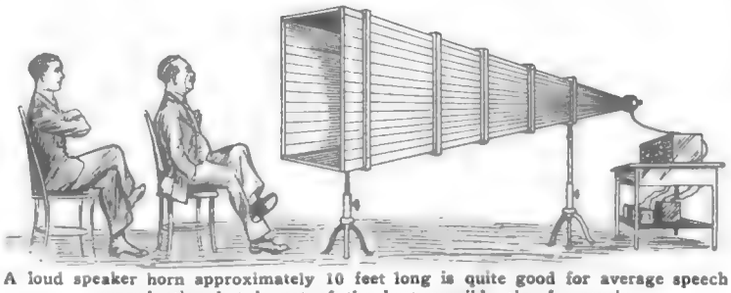
"Perhaps the least understood and most abused acoustic feature of radio receiving is the so-called "horn" of the loud speaking telephone. Many inventors and manufacturers seem to think that the material of the horn itself is the essential thing, but it is not so. The horn is simply a shell that separates a certain quantity of air of a certain shape from the general mass of air filling the room in which the loud speaker is located; the thing of acoustic importance *is the cone of air contained inside the horn.* The small end of this cone of air rests on the center of the diaphragm of the receiving telephone and constitutes what, in analytical mechanics, is called a "load" on the diaphragm. The air in the horn is disconnected from the main body of air throughout the length of the horn; it is thus an elastic body capable of its own independent vibration. At the open end of the horn it connects with the air in general. The loud speaker may be likened to an acoustic broadcasting station, in which the air in the horn is the antenna.

"The back and forth movements of the diaphragm which are produced by the electromagnetic devices must, in a loud speaker, be communicated to the air in the auditorium with a considerable increase in the amount of energy radiated, as compared with a simple ear telephone; that is, the sound must be *amplified.* This amplification results from the reaction on the diaphragm of the column of air contained within the horn. With the horn attached, the diaphragm is *loaded* and does more *work* than when unloaded, just as a motor delivers more power under load than when running light.



Here is shown the average type of loud speaker horn with the "morning-glory" shape. It is not the best type.

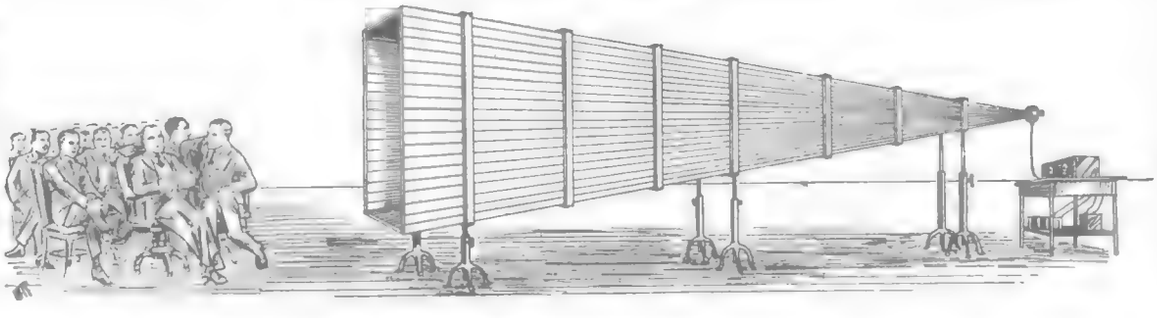
"When the air-column in the horn is made to vibrate in response to the movements of the diaphragm, what are called stationary air waves, with nodes and loops, are formed. It follows naturally that a short horn, enclosing a short column of air, cannot respond to sounds of long wave-length. The sounds of speech of a baritone voice contain component waves having a length of ten feet or more, and orchestral music contains sounds having waves twenty feet or more in length. A short horn can never give an adequate reproduction of such sounds.



A loud speaker horn approximately 10 feet long is quite good for average speech reproduction but is not of the best possible size for music.

"Investigations show that the exponential horn, that is one in which the increase in cross-sectional area is uniform throughout its length, is distinctly better than one of the so-called *morning-glory* type; preferably it should be

If a loud speaker horn 20 feet long is employed, practically all musical and vocal tones will be reproduced at their best and with a minimum of distortion.



The illustration at the left shows an excellent type of loud speaker horn 20 feet long. It is of the recommended evenly tapering type that has been found to be the best.

Above is shown the average size cone in general use today which gives fair reproduction of the majority of tones.

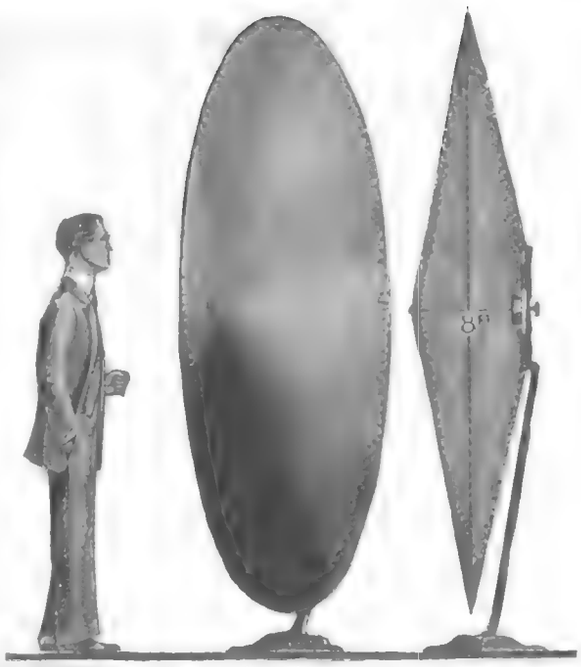
straight; it should be at least eight feet long. Probably metal is the best material, the inside being smooth and polished and without obstructions of any kind. Many trials with such a horn indicate conclusively that speech rendered by it is more natural and music very much more musical. The richness and tonal body of orchestral tone-color is reproduced marvelously well. To appreciate these effects one must listen to a loud speaker equipped with such a horn."

It was with the facts propounded by Prof. Miller in mind that the author of this article proceeded to design the various types of loud speaker horns that are shown on this and the preceding page. Of course, it is obviously impossible to incorporate a 20-foot horn in an ordinary room, but if some serious minded experimenter desires to do so, there is no reason why such a horn could not be built in the attic of a house, with the mouth directly over a veiled opening in the ceiling of the floor below. This is shown in detail in the drawings on the preceding page. It will be noted that holes may be cut in the walls and floors of the various rooms and so the sound could be distributed throughout the house. Shutters could be arranged over these holes so that when desired, the sound could be cut off.

Another good idea and one that is within the reach of a good many radio experimenters is to use the hot air furnace distributing pipes for loud speaker horns. A reproducing unit could be placed in the furnace as shown or, what would be preferable, in the cold air intake. The sound would then be distributed throughout the entire house.

Some interesting experimental work has been recently performed by the engineers of some of the largest radio companies wherein various sizes of cone type speakers have been tested. Some excellent results have been obtained with loud speakers having an outside diameter of 8 feet and these enormous conical diaphragms have been driven by ordinary reproducing units.

A large cone speaker is shown at the top of this column and should give some very good ideas to experimenters. A cone of this nature could be made by gluing together large sheets of paper.

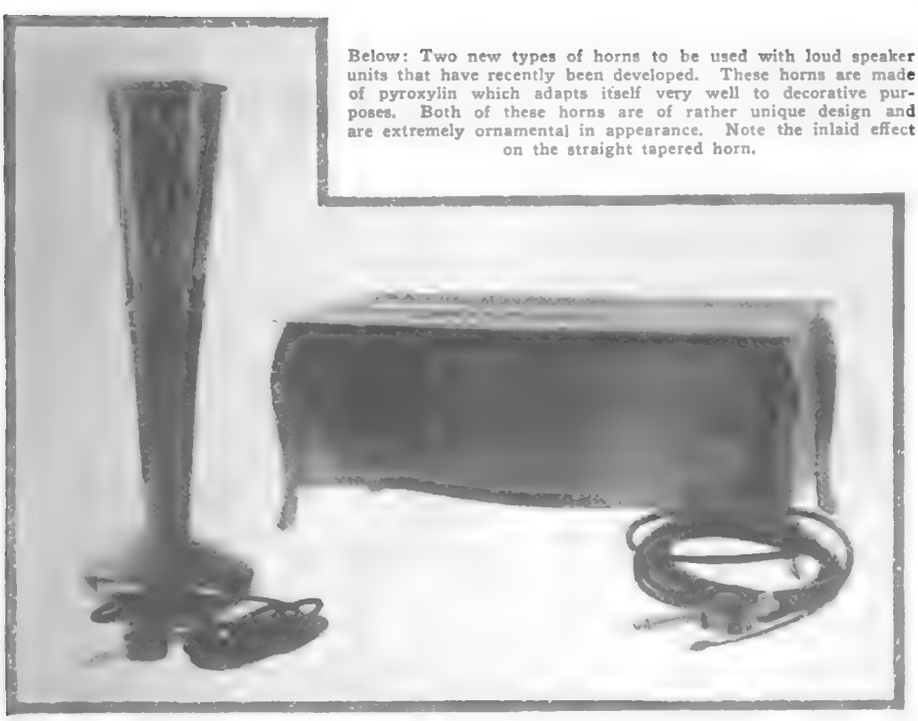


Above: An 8-foot cone loud speaker. Some working models of this size have been constructed and have been found to give exceptional results.

Extreme left: Morning-glory type of horn. To the right of this is shown an evenly tapered horn, curved so as to fit a small space and directly below these two illustrations is the best possible type.

New Loud Speakers

A New Non-Resonant Material Makes Excellent Horns



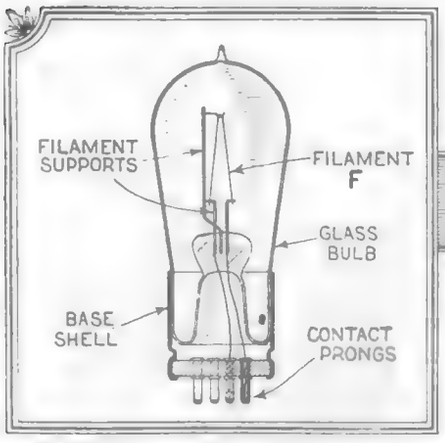
Below: Two new types of horns to be used with loud speaker units that have recently been developed. These horns are made of pyroxylin which adapts itself very well to decorative purposes. Both of these horns are of rather unique design and are extremely ornamental in appearance. Note the inlaid effect on the straight tapered horn.

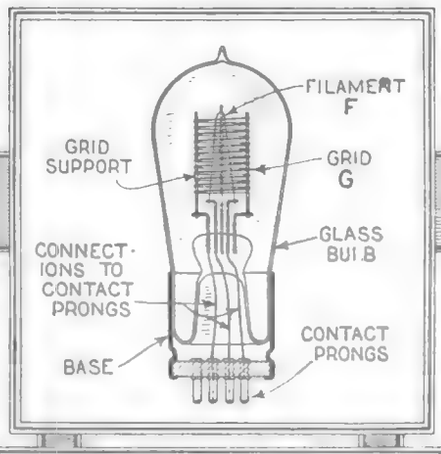
WHY must the loud speaker used in connection with a radio receiving set always be more or less of a detriment to the appearance of the room in which it is located? It need not be at all if some judgment is used in the selection of the material and style used in the manufacture of the horn. For instance, we illustrate at the left two radically different types of loud speaker horns that would make a decided addition to any radio receiving set. Made of a cellulose composition, one of them resembles a flower vase in shape whereas the other is built in the popular console style. Absolutely no metal is used in the construction and since the composition is of a non-resonant nature, there can be none of the "tinny" effects that are often noticed with metallic horns. Our readers will undoubtedly note that in the flower vase type of horn, one of Prof. Miller's suggestions has been carried out. As put forth in the article above and on the opposite page, the ideal loud speaker horn has a regular taper from the reproducing unit to the mouth.

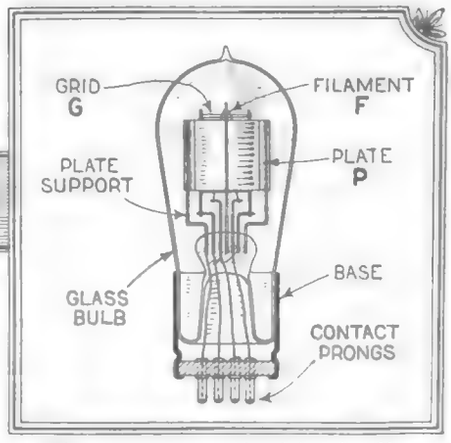
The composition from which these loud speakers are made lends itself very nicely for decorative purposes. Various colors can be employed to give a mottled effect and inlays can also be produced.

Photos courtesy E. I. Dupont de Nemours & Co.

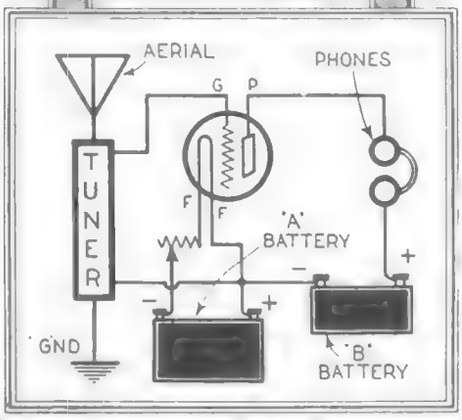
How a Vacuum Tube Operates



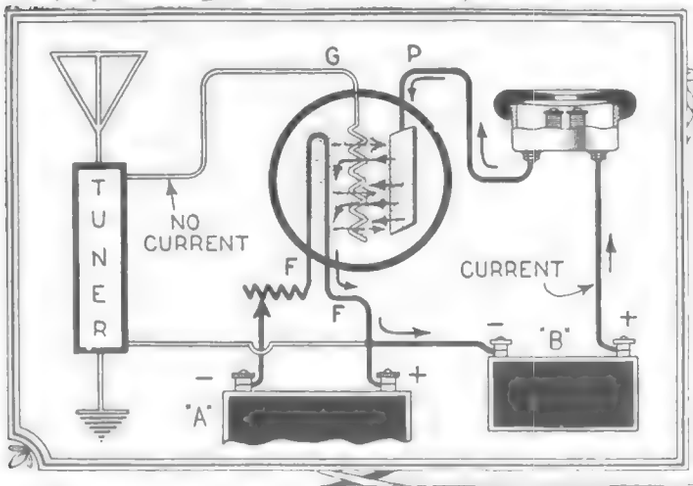


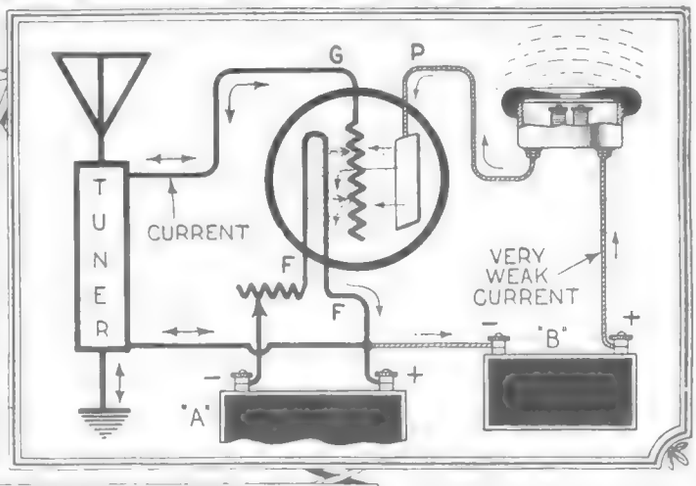


VERY few of those interested in radio reception in the usual way are thoroughly familiar with what goes on inside of a vacuum tube. A majority of the sets in general use today employ these instruments, but they are more often than not considered to be more or less of a mystery. The illustrations and text on this page show and tell just what takes place inside of a detector tube. Before entering into this part of the description, let us note the various elements of a standard vacuum tube as illustrated in the three drawings across the top of this page. First we have the filament F, in the illustration directly above. This supplies the electrons mentioned at right.

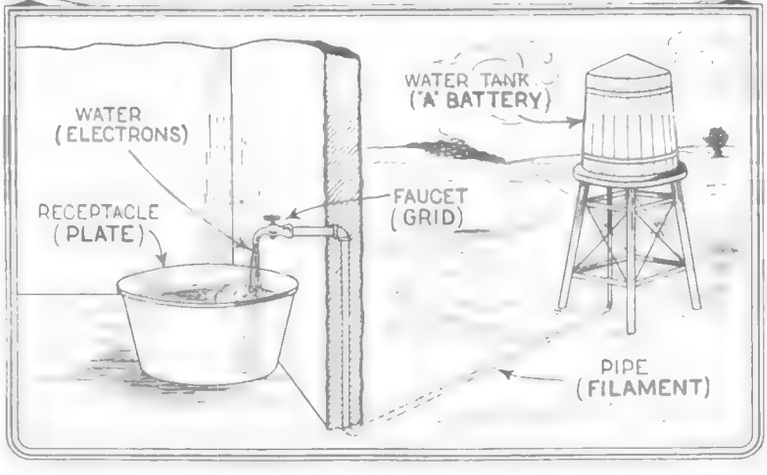


THE electrons emitted by the filament are the conveying medium in a vacuum tube and make it possible for a current to pass in one direction through the tube, but not in the other. The other two elements of a vacuum tube are the grid, G, shown in the center illustration above and the plate, P, shown directly above. The grid might be called the controlling element and the plate the receptacle for the electrons thrown off by the filament when it is heated by the current supplied by the "A" battery. The circuit for a vacuum tube is shown in a simplified way at the left. The "A" battery lights the filament, the "B" battery actuates the phones when it is "triggered off" by the grid.





A GENERAL discussion of vacuum tube action follows. Note illustration above. No current is flowing from the tuner to the grid as no signal is being received by the aerial. Therefore, the "B" battery current flows through the phones, attracting the diaphragm. This current flows along the electronic stream set up by the filament. When current flows to grid as at the right of the above illustration, the grid becomes charged and attracts or repels some of the electrons so that many do not reach the plate.



WHEN the grid becomes charged, the current in the plate circuit is weakened, and changes rapidly; the diaphragm of the phone gives off sounds.

Left: An analogy of the operation of a vacuum tube. As the faucet (grid) is controlled, the flow of water (electrons) may be made faster or slower as desired. We only have to imagine a current flowing along this stream of water to see that it will be strengthened and weakened in accordance with the flow of water. ABNER J. GELULA.

An Experimental "D" Coil Coupler

By HERBERT E. HAYDEN

All Constructional Details for Making and Winding One of These Instruments

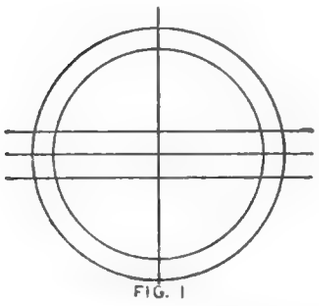


FIG. 1

Above: Two circles and two diameters have been drawn on the cardboard and two lines parallel to one of the diameters have been inscribed as shown.

Right: Eight lines have been drawn parallel to the vertical diameter and intersecting the concentric circles. This is all fully described in the text.

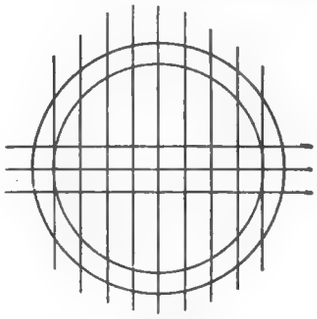


FIG. 2

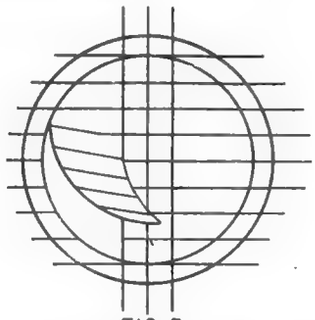


FIG. 3

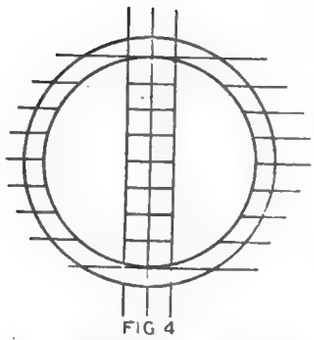


FIG 4

Above: The two sections to the left and right of the dividing lines have been cut out. The next step will be to cut around the outer circle and then cut the "D" sections apart.

Left: A sharp narrow-bladed knife is employed for cutting out the two sectors. One of them is shown partially cut. When cut, the appearance will be as in Fig. 4.

OF the many forms of low-loss inductances the "D" coil lends itself to many interesting experiments. To make a "D" coil variocoupler secure a piece of fairly thick cardboard (about 3/16 of an inch) and draw a circle as shown in Fig. 1 making the diameter 4½ inches. Next an inner circle 4 inches in diameter is laid out. Two diameters at right angles to each other are drawn, then two more lines ½ inch each side of the center as shown, and parallel to one of the diameters.

Then at right angles to these lines draw four lines each side of the center line ½ inch apart, making a total of nine lines in this set parallel to each other, counting the one diameter.

Then with a very sharp pen-knife, start peeling out one section as shown in Fig. 3. Do not try to cut through the cardboard with one cut, and by all means use a sharp knife. After cutting out the sections of the semi-circles we get the results shown in Fig. 4.

After securing the cardboard to the table by tacking it down lightly or with thumb tacks, cut a hole (Fig. 5) each side of the center line, one hole being drilled with a No. 27 drill, the other with a ¼-inch drill. The two halves or semi-circles are now cut apart, and notches cut as shown in Fig. 6, on the lines previously drawn. It will be noticed that where the shaft passes through the cardboard a little notch has been cut each side of the shaft hole, making ten notches on the straight side of the "D" and nine notches on the circumference or outer edge.

The winding is now started. Of course any size magnet wire in common use can be used although this does not include No. 14, as this heavy wire would be difficult to handle and would probably crush the form.

Also a variety of "couplings" can be arranged. For instance, instead of winding a straight winding around the "D" coil in the usual fashion, a combination winding can be arranged, giving for example a coupling effect of nine to one.

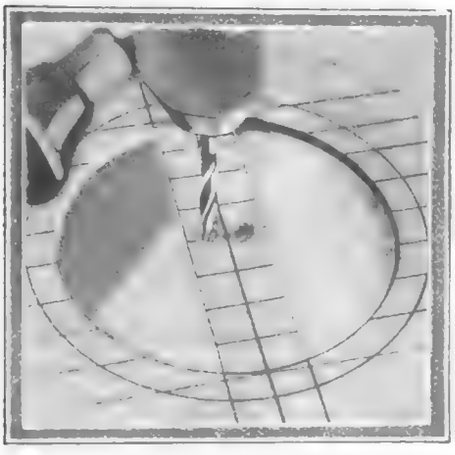


Fig. 5. Drilling the center holes in the sections before cutting them apart. These holes are for the shaft. Work carefully to avoid breaking the cardboard.

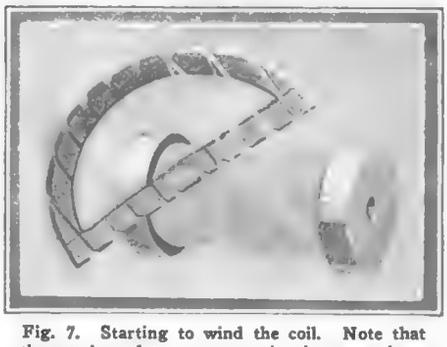


Fig. 7. Starting to wind the coil. Note that the number of turns per section increases from one end of the "D" to the other. The exact details will be found in the text.

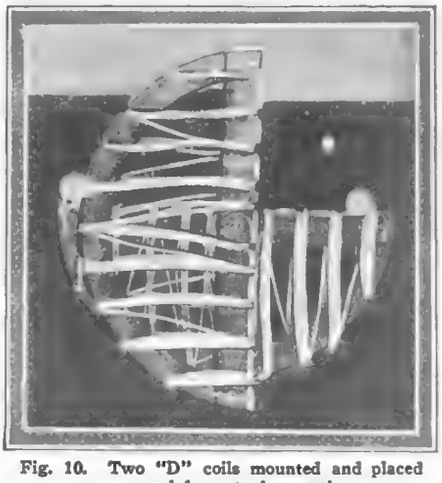


Fig. 10. Two "D" coils mounted and placed on a panel for actual operation.

This is accomplished in the following manner. Start at the first notch, Fig. 7, and wind one turn. Then bring the wire down to the second notch and wind three turns. Over notch four, place four turns then at notch five, on the outside of the "D," wind five turns and split this across the center shaft hole, putting two turns in each notch and ½ turn on the cross-over, then continue winding six turns in notch six—seven in notch seven—eight in notch eight, and nine in the last one.

The finished coil appears in Fig. 8. The windings are made fast by drawing a needle through the cardboard and threading the wire through the hole thus made.

The other cut out "D" form is wound in the same manner, and when the winding

(*Continued on page* 91)

Fig. 8, below: One of the "D" coil forms completely wound and ready for mounting on the shaft. Notice and follow the particular type of progressive winding shown.

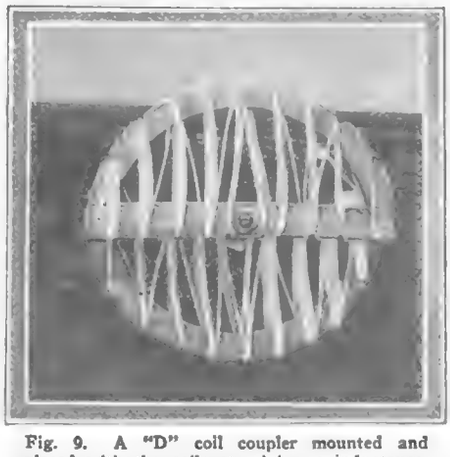
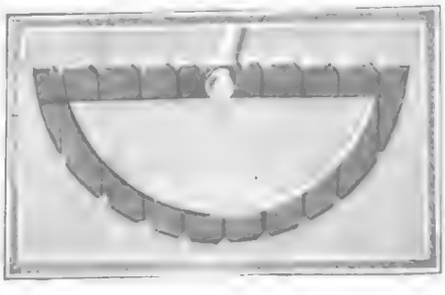


Fig. 9. A "D" coil coupler mounted and placed with the coils at minimum inductance.

Fig. 6, below. A stationary "D" coil form is shown with the insulating shaft passing through the bearing hole.



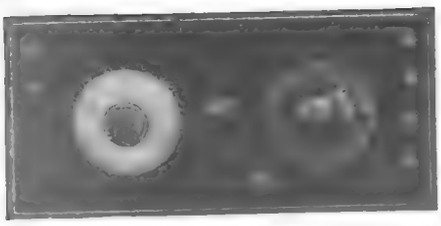


Fig. 1. Panel view of the short wave set which has picked up signals from every corner of the globe. Panel mounted terminals are used.

The Radio Constructor

By LEON L. ADELMAN, 2AFS and ALFRED R. MARCY, 2DK

An Interesting Article Dealing with the Final Perfection of a Remarkable Short-Wave Receiver which has Picked Up Signals from Every Corner of the Globe

EVER since Mr. Hugo Gernsback, editor-in-chief of SCIENCE AND INVENTION and Radio News made the prophecy in an editorial several years ago that successful 'round the world transmission would some day be accomplished with but a mere few watts of power, amateurs and experimenters have worked ceaselessly in the endeavor to fulfill it.

When in 1912 the amateur received his first official curb, the leading radio men of that day believed that the amateur was out of the way for all and good. For, they argued, what can be done on the ridiculously short wave-lengths of 200 meters and lower. Even the great Marconi pointed out that his experiments proved that the longer wave-lengths were the best and as a result, commercial interests loudly applauded the then existing situation.

Then came the intervention of the great war. For a period which seemed ages, the American amateur was not allowed to listen in, send messages, or even experiment with radio. But it was during this period, that the country realized the potency of one of her greatest assets. The need for men to fill the ranks of the Signal Corps was immediately met by great numbers of amateurs. The results are only too well known and while the amateurs were on the other side of the ocean, many new developments were credited to their ability.

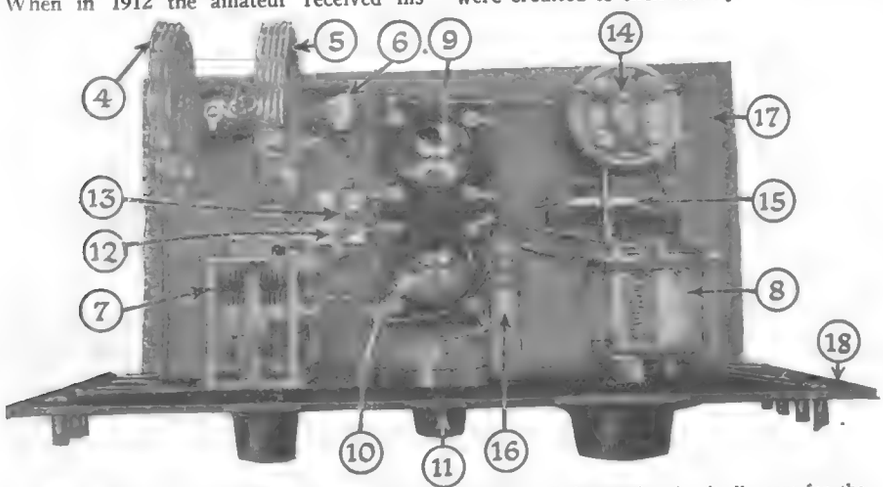


Fig. 3. Plan view showing the neat and efficient layout. Refer to the circuit diagram for the key numbers of the apparatus used in the construction of this receiver. The two binding posts on the left of the panel are the antenna and ground posts. The four on the right are from top to bottom, respectively "B" amplifier, "B" detector, "A" and "B" minus and "A" plus. One rheostat controls the two tubes. *Photos courtesy of Radio Engineering Laboratories.*

Coming as they did from all walks of life and working toward one common goal, it can readily be understood that after Reinartz announced his marked success with his new receiver, thousands of amateurs built the set and pronounced themselves well satisfied with the results.

But Reinartz did not stop here. It is the usual thing that an inventor remains obstinate or becomes stubborn when asked to or is prompted to improve his work, but not so with Reinartz. The short waves were his goal. He remembered that Hertz in his pioneer experiments had had some success with short waves, but that seemingly, no one had elaborated upon these experiments or had even duplicated them. With grim determination, he set about to explore the higher frequencies. First 150, then a few meters lower and again with the achievement of the 100-meter mark, the entire radio amateur fraternity was aroused.

Not satisfied, continual experiments not only by Reinartz, but by a host of contemporaries soon paved the way for 80, 40 and even 20 meter work.

So good were the results and so enthusiastic were the amateurs that the government by permission of the Army and Navy departments gave the amateurs temporary use of the lower wave bands, which they still enjoy.

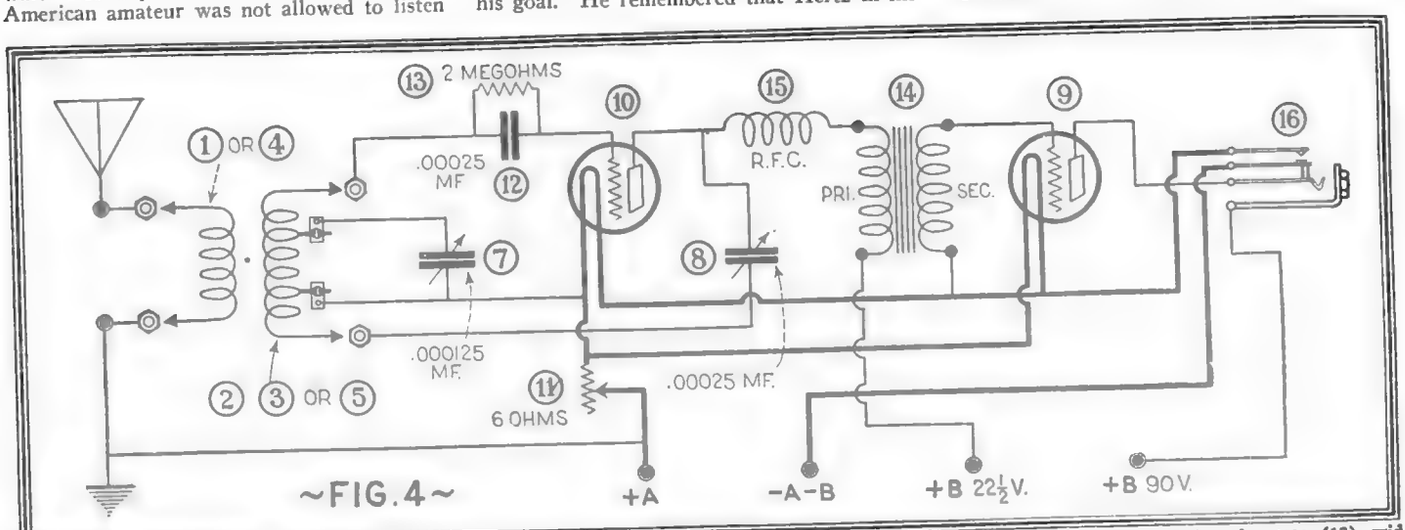
THE REINARTZ CIRCUIT USED

There soon appeared the improved Reinartz receiver and many other changes and modifications. But after a thorough test of them, the authors felt that there were still better results to be obtained. And so, with the view in mind to produce a more reliable and better short wave receiver, the set to be described was finally brought to its highest efficiency.

A modified Reinartz circuit is the one used. Care was exercised in the selection of the various parts entering into its construction and when the set was finished and tested, it left no more to be desired.

Referring to the photos and diagram, the following numbers will identify the parts:

1—6-turn primary coil for 15- to 30-meter band.
2—27-turn secondary coil for 45- to 110-meter band.
3—7-turn secondary coil for 15- to 30-meter band.
4—9-turn primary coil for 25- to 55- and 45- to 110-meter band.
5—12-turn secondary coil for 25- to 55-meter band.
6—Coil mounting strip.
7—.000125-mf. tuning condenser.
8—.00025-mf. feed-back condenser.



The wiring diagram of the receiver showing the parts and their designations. (1 or 4) are the primary coils; (2, 3 or 5) the secondary coils; (6) coil mounting strip; (7) .000125 tuning condenser; (8) .00025 feed-back condenser; (9) amplifier socket; (10) detector socket; (11) 6-ohm rheostat; (12) grid condenser; (13) grid leak; (14) audio transformer; (15) radio frequency choke; (16) filament control output jack; (17) baseboard; (18) panel.

9—Amplifier socket.
10—Detector socket.
11—6-ohm rheostat.
12—.00025-mf. grid condenser.
13—2-meg. grid leak.
14—4 to 1 ratio A.F. transformer.
15—125-turn R.F. choke on 1-inch cardboard tube.
16—Filament control output jack.
17—Baseboard 6 x 13 inches.
18—Panel 7 x 14 inches.

It may be found quite difficult to locate a .000125-mf. tuning condenser and in the case that you cannot find one, a standard .00025-mf. instrument having 11 or 13 plates may be cut down so that it contains only 5 or 7 plates. This may be accomplished by removing spacing washers if a type of condenser containing them is in the set or by carefully removing the plates from the slots in the supports if this type of construction is to be employed. In either event, use very great care to avoid bending the other plates and be sure that all of the plates are lined up when the instrument is assembled.

Before one starts to construct this short-wave receiver, he should study the arrangement and layout of the parts. This is essential and such study should be adhered to rigidly. Note the short leads. Those who have built short-wave sets will realize their importance. The tuning of this receiver is practically single control. The feed-back condenser will be found to give excellent control for the various wave bands and need only be adjusted for a change in the coils used. This should recommend the receiver to those who want much easier control and wish to follow the swinging of signals with greater rapidity and accuracy.

INDUCTANCES

There is one concern manufacturing a set of five short wave coils especially designed for use in a receiver of this nature and these coils are illustrated in the various photographs here. In Fig. 2, three of the coils will be seen beside the set, while the other two are mounted on the jack strip. In case the reader does not know where to purchase coils of this nature, a stamped addressed envelope addressed to the Radio Editor will bring this information.

The secondary coils are tapped, as the diagram and photos will show. Very sharp tuning is thus allowed. No body capacity effect is evident and the set will oscillate over the entire band from below 15 to above 110 meters. The details of the tapped coils are as follows:

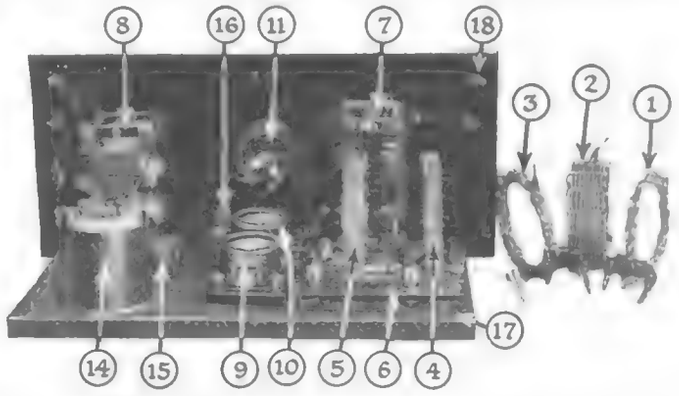


Fig. 2. Rear view of the set in which is clearly seen the arrangement and disposition of the parts. Note the extra coils alongside. These are in readiness for the purpose of plugging in to cover other wave-length ranges. Particular regard should be paid to the fact that the coils are so placed that they are far from the metallic parts of the other instruments. Porcelain sockets are used.

Coil	Total Number of turns	Plate Coil	Tuned Section	Grid Coil
(3) 20 m	7	1½	3¼	2¼
(5) 40 m	12	4½	5	2½
(2) 80 m	27	6½	10	10½

If it is desired to tune in on the 200-meter band, the following constants for a coil for that purpose will serve: 35 turns total; 10 in plate coil; 20 in tuned section and 5 in grid coil.

The taps on the secondary coils include the portion known as the tuned circuit. They are connected to the variable tuning condenser by means of flexible leads. These leads are each 5 inches long and terminate in clips which grip the taps very tightly. This method of connection facilitates the rapid change of coils when it is desired to change from one wave-length band to another.

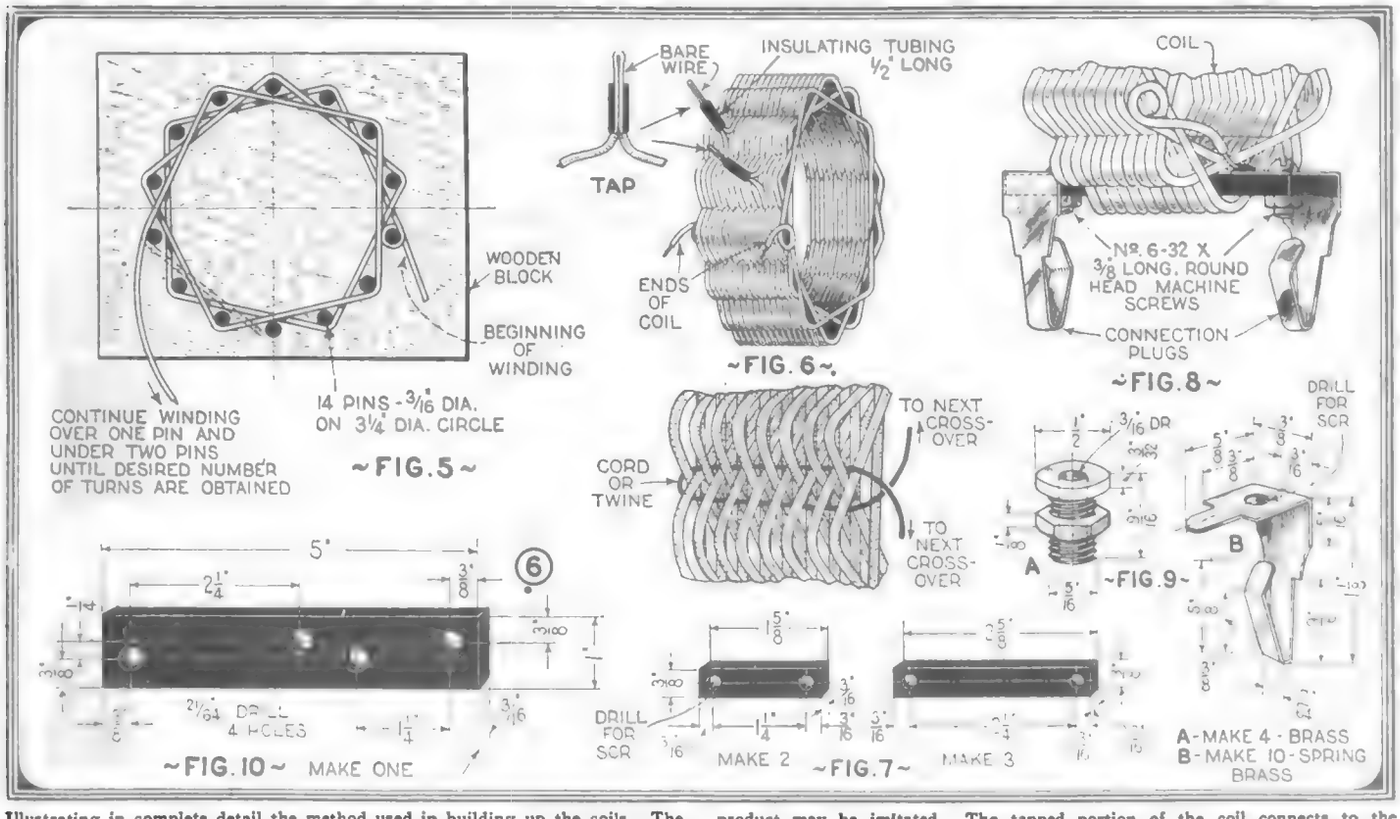
WINDING THE COILS

For those who desire to construct their own coils, a winding form must first be made. This can be done by taking a piece of board about 6 inches square and placing 14 three-inch headless nails in a 4-inch diameter circle. The coils are then wound according to the specifications given. Note that the turns alternate between every two other nails. Number 16 D.C.C. wire or better still, bell wire is used. Taps should be taken off in the manner shown in Fig. 6. After that, the winding should be securely bound with waxed cotton thread, as seen in the same figure.

The mounting strips are of bakelite, hard rubber, radion or celeron, and no difficulty should be experienced in making them. They are shown in Figs. 7 and 10.

When the coil has been made ready for mounting, slip or force the strip of insulating material between the wires and drop a small piece of molten sealing wax on the wire and strip as in Fig. 8. This will be

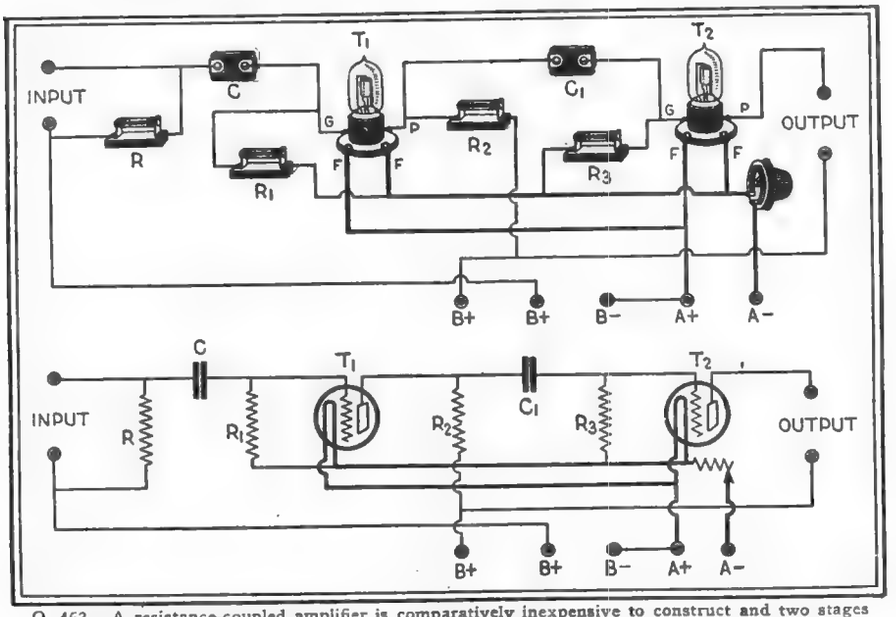
(*Continued on page* 91)



Illustrating in complete detail the method used in building up the coils. The construction of these coils is relatively simple, but it is stressed that the specifications be followed to the letter, as it is most important to have them of correct inductance value, and minimized resistance. The manner of making the taps is also clearly depicted and with careful work, the factory-finished product may be imitated. The tapped portion of the coil connects to the variable tuning condenser, as shown in the diagram on opposite page. The coils need not necessarily be made by hand, as they can readily be purchased at a nominal cost. Figs. 5 to 10 show the various stages in the assembling of a complete coil.

RADIO ORACLE

In this Department we publish questions and answers which we feel are of interest to the novice and amateur. Letters addressed to this department cannot be answered free. A charge of 50c. is made for all questions where a personal answer is desired.



Q. 462. A resistance-coupled amplifier is comparatively inexpensive to construct and two stages will give fair volume although not as much as a two stage transformer-coupled amplifier. The above diagram shows a standard two stage resistance-coupled amplifier.

RESISTANCE COUPLED AMPLIFIER

(462) Q. 1. Frank Staats, LaCrosse, Wis., asks: Can such an arrangement as a two-stage resistance coupled amplifier be made up and if so, please show a diagram of the same, giving all the constants for the various parts.

A. 1. It is entirely possible to make up an amplifier of this nature, although it will not give as much reproduced volume as a standard two stage transformer coupled amplifier. However, the reproduced music and voice will be somewhat clearer with this type of amplifier. You will find the required diagram in these columns and the constants are given here. We have shown the diagram with all the binding posts indicated that will be necessary to use in order to make up a two stage unit to be added to any type of radio receiving set. The resistors, R, and R2, should have an average value of 100,000 ohms each. The condensers, C, and C1, should have a capacity of .006 mf. each. The resistor, R1, should be a 1-megohm grid leak and the resistor R3 should have a resistance of ¼ of a megohm. These values are given for standard UV-201A or UX-201A tubes. With such tubes, the "B" battery voltage applied to the audio amplifiers should be on the order of 135 volts. The detector voltage may be determined by experiment and should be between 22½ and 45 volts.

FOUR TUBE SET

(463) Q. 1. E. C. Clarke, Jacksonville, Fla., has built the four tube receiver described in the March, 1926, issue of SCIENCE AND INVENTION Magazine and finds two sources of trouble with it. In the first place, the regeneration control does not seem to have much effect on the operation of the set and the second trouble is that a whistle is heard when the loud speaker is plugged into the second stage of audio frequency amplification. He asks if we can help him to remedy these defects.

A. 1. In the first place, we would advise you to look to your regeneration control condenser. Is it of the correct size and as you vary it from zero toward maximum, do you obtain an increase in signal strength up to a certain point where a click is heard and the music becomes very distorted? If this happens, your regeneration control is operating properly and you will undoubtedly find that your trouble lies in the audio freuqency amplifier. By the way, if the regeneration control works over the entire wave band as described, a choke coil in the plate circuit of the detector is not necessary.

The writer had a trouble somewhat similar to the second one which you mention, namely a whistling that at times was very annoying and prevented "DX" reception. It was found that shunting the secondary of the second audio frequency amplifying transformer with a fixed condenser entirely eliminated this whistle and cleared up reception remarkably. We far prefer this system to the usual resistance control of noise. The condenser that the writer uses is of a capacity of .0005 mf. However, the various sizes should be tried until the best results are obtained. This condenser in any case should not be larger than .001 mf.

In case the condenser does not clear up your trouble, make sure that you are not obtaining an audio frequency feed-back in your receiver. Possibly the audio transformers are close together or their cores are parallel and if such is the case this will of course take place. In such an event, separate the transformers or turn them at right-angles to each other. Occasionally grounding the cores or the metal cases or both of the transformers will be of considerable assistance.

One further thought is that the grid leak that you are using may not be of the correct value.

POWER TUBES

(464) Q. 1. Morris Steiner, Rochester, N. Y., asks: Will the addition of a power tube in the second stage of my three tube receiver result in better signal strength?

A. 1. Louder signals will undoubtedly be found if a standard power tube is employed, and if care is taken to apply a higher voltage to the plate than is ordinarily used for a second stage audio frequency amplifier. With the power tubes on the market today use at least 135 volts on the plate; 150 volts will probably be found even better. Also increase the "C" battery to at least 6 volts and preferably to 9 volts for the last stage amplifier. With certain types of power tubes, it will be necessary to change sockets or use an adapter, whereas with others, the standard socket may be employed, but it will be found that more current will be drawn from the "A" battery. In such an event a suitable rheostat must be employed to handle this current.

BODY CAPACITY

(465) Q. 1. A. Johnson, Minneapolis, Minn., is employing a regenerative tuner of the so-called three-circuit type and finds that he has considerable trouble holding the signals when he places his hand on the variable condenser dial. Furthermore, when he tunes in a station and removes his hand from the dial, the station usually disappears. He asks us to tell him how to eliminate this trouble.

A. 1. Undoubtedly reversing the connections to your secondary tuning condenser will eliminate most, if not all, of your trouble. In other words, the rotary plates of the condenser should be connected to the ground. By doing this, the parts of the variable condenser that are near at hand will be placed at ground-potential so that the capacity effect of the hand will be reduced to zero. If, for some reason, thi connection does not overcome the effect which you have noticed, try shielding the panel. Do not allow the metallic parts of the condenser to touch the metal shield, which should consist of a sheet of tinfoil fastened to the panel with some adhesive, such as shel'ac. This shield should be connected to the ground.

LOUD SPEAKER

(466) Q. 1. Fred Bailey, Pasadena, Calif., wants to know if it is advisable to purchase one of those types of loud speakers in which an ordinary phone unit is to be clamped to the small end of the horn.

A. 1. An ordinary type of headphone or receiver is not designed to carry sufficient current to operate satisfactorily as a loud speaker. This, of course, is not true in all cases, and if you employ some type of receiver in connection with the horn you mention that has been designed to withstand the heavy currents found in the plate circuit of the last tube of an amplifier, you may expect quite good results.

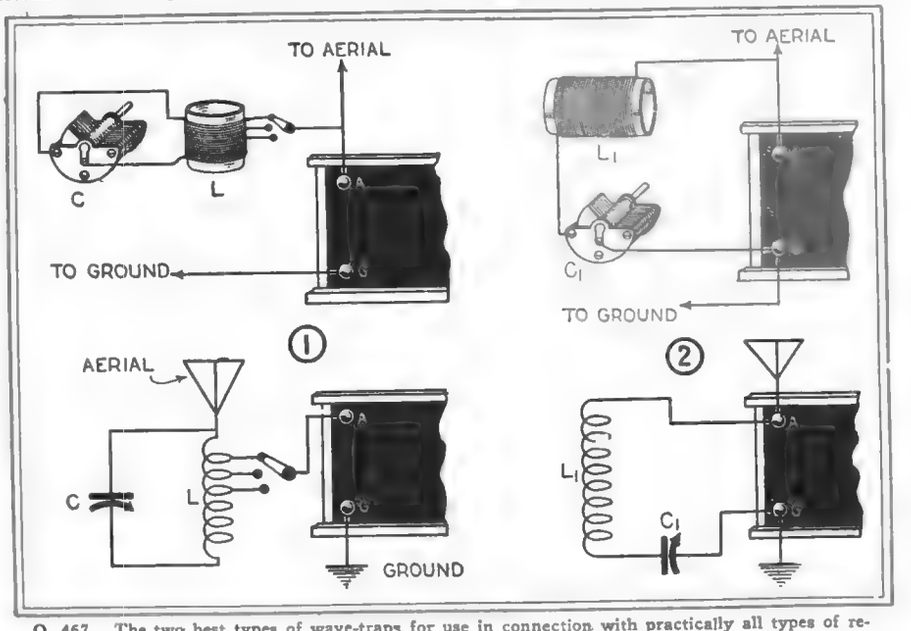
WAVE-TRAP

(467) Q. 1. J. B. Hinds, Orlando, Fla., asks our opinion as to the best type of wave-trap and also requests us to show a diagram of it.

A. 1. This cannot be answered with one statement. There are, generally speaking, two best kinds of wave-traps and they are suitable for different types of sets. We are illustrating both of them in these columns and would say that type No. 1 is suitable for practically all types of receivers with the exception of those having untuned or semi-aperiodic primaries. No. 2 is adaptable to this latter type of set and will give the best results when used in connection with it.

In trap No. 1, the condenser C should have a maximum capacity of .0005 mf. and the inductance, L, should consist of 60 turns of No. 22 D.C.C. wire, wound on a 3-inch diameter tube. This winding is tapped at the 10th, 20th and 30th turns and the taps are connected to a 3 point switch as shown.

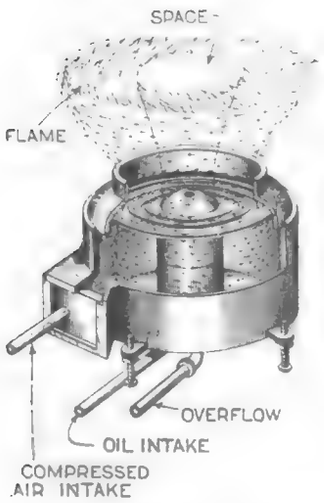
In trap No. 2, variable condenser, C1, has a capacity of .0005 mf. and the inductance, L1, is wound on a 3-inch insulating tube and consists of 110 turns of No. 22 D.C.C. wire. There are no taps made on this coil and it is merely connected in series with the condenser and the combination connected across the antenna and ground posts of the radio receiving set as shown.



Q. 467. The two best types of wave-traps for use in connection with practically all types of receivers are shown above. The distinctions between them are pointed out in the text as are also the kinds of sets with which they are to be employed for best results.

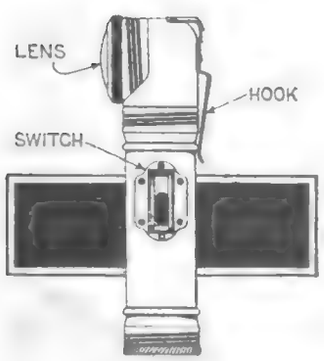
LATEST PATENTS

OIL BURNER



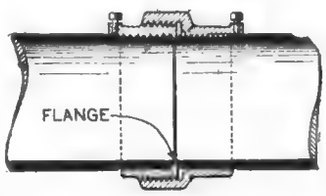
No. 1,569,967, issued to Wilhelm G. Danielsen, describes a novel type of oil burner illustrated above for which it is claimed that noiseless operation and great efficiency can be obtained in its operation. In this burner, compressed air is forced in, and assuming a whirling motion, due to the shape of the interior, it atomizes the oil and throws it upward in a cone-shaped vortex as shown. The burner-housing is not subjected to a great heat.

FLASH LAMP



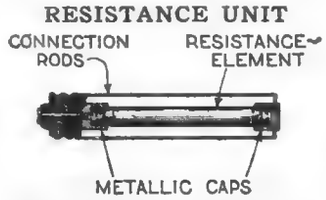
No. 1,570,393, issued to Charles Osean, protects the design of a novel type of flashlight such as that shown above. Attachments are provided so that it can be hung on the belt of the user and so that it can be attached to a nail driven in a wall or other convenient place. When suspended in this manner, the light is thrown directly ahead by reason of the lens being placed at right-angles to the body. A convenient switch is incorporated.

PIPE COUPLING



No. 1,570,155, issued to Victor Karbowski, relates to improvements in the design of pipe connections or couplings and in one of its parts describes the type of connection shown here. There are two important sections to this union, one of which screws on one of the pipes to be joined, a flange on it acting as a packing ring. The second part screws on the other pipe and also over the first part of the coupling as illustrated. Set screws make sure that the joint will not loosen.

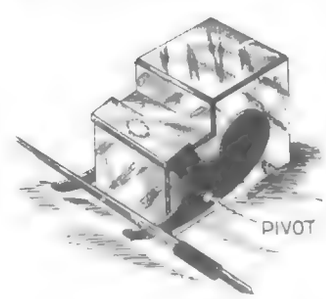
RESISTANCE UNIT



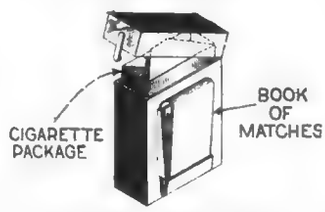
No. 1,570,084, issued to Thomas C. Russell, describes a new type of electrical resistance element for use in electric heat-producing devices. It consists of a non-metallic material molded into a rod form such as that shown and equipped with electrically plated metallic caps. These provide for excellent connections. These resistances work up to 2,400° F.

INK WELL

No. 1,571,252, issued to Ray Famulener, describes the combination ink well and pen rack shown above. Placing the pen in the position shown pivots the rack and causes the upper portion of it to cover the hole into which the pen is to be dipped in order to obtain a supply of ink.

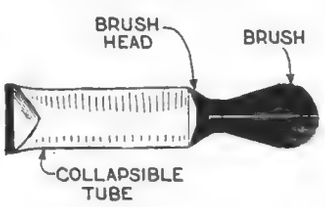


MATCH AND CIGARETTE BOX



No. 1,570,038, issued to Millard D. Burris, is descriptive of the combination cigarette box and holder for paper matches illustrated in this column. A standard type of metallic or other holder for package of cigarettes is provided with a clip on the side so that a box of the well-known type of paper matches can be inserted therein and will be held in a convenient position for use at all times. Thus, cigarettes and matches are always at hand.

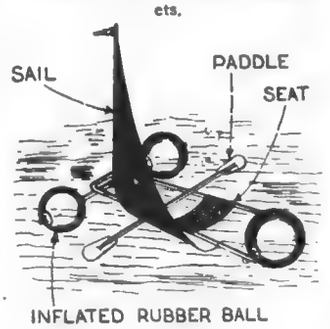
SHAVING BRUSH



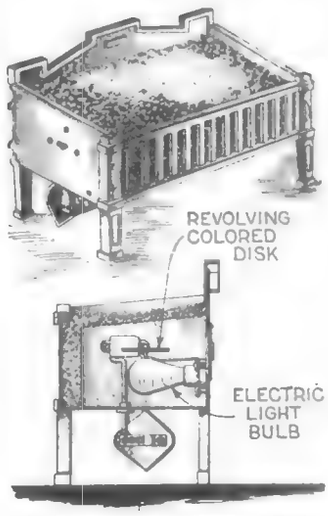
No. 1,571,136, issued to Samuel Moore, Jr., covers the design of a shaving brush shown above. It is equipped with a threaded recess so as to be attachable to a collapsible tube of shaving cream. The cream issues through the channel shown.

SWIMMER'S RAFT

No. 1,567,555, issued to Nicholas Straussler, protects the swimmer's raft shown above which is equipped with a sail and which can also be propelled through the water by means of a single or double paddle. Its buoyancy is obtained through the use of a set of inflated balloonets.



FIRE-PLACE



No. 1,567,855, issued to Daniel N. Meany and Edward N. Ellsworth, describes the electric fire-place shown in the above illustration. A surface of imitation coal is supplied and under it, a colored disk revolves, driven by the rising heat from an incandescent bulb. This gives the illusion of an actual fire in the grate. A heating unit is incorporated in the base so as to provide warmth to the room in which the fire-place is located.

NUTCRACKER

No. 1,560,349, issued to John W. Schweitzer, covers the novel type or nutcracker illustrated. By placing the nut between the jaws and pressing downwardly on the lever, the shell of the nut is easily cracked. A rack-and-pinion incorporated within the standard make this possible and a great increase in leverage is obtained by proper design of the entire unit. The standard is placed in a bowl designed to receive the broken shells.

NOTICE TO READERS. The above illustrated and described devices have recently been issued patent protection but are not as yet to our knowledge available on the market. We regret to advise that it is impossible to supply the names and addresses of inventors of the above devices to any of our readers. The only records available, and they are at the Patent Office at Washington, D. C., give only the addresses of the inventors at the time of application for a patent. Many months have elapsed since that time, and those records are necessarily inaccurate. Therefore, kindly do not request such information.

—EDITOR.

Scientific Humor

WE NEED A SET NOW

1ST NEIGHBOR: "When I realize the wonders of radio, it makes me think."

2ND NEIGHBOR: (absent-mindedly) "Yes, isn't it wonderful what radio can do."—*Carl C. Slaybaugh.*

SAYS NOTHING ABOUT BEING NERVY

VETERAN MEDICAL EXAMINER: (To a young student) "What muscles will I call into play if I raised my foot and kicked you?"

YOUNG STUDENT: (With a menacing glare) "The flexor and extensor muscles of my right arm."—*Jack Harvey.*

THE LEAGUE OF NATIONS

"How was your last cook?"

"She was an Irish girl who talked Turkey, smoked Egyptian cigarettes, drank Scotch, got her Dutch up and took French leave."—*Ella Levy.*

IS THERE A WHIP STATION?

SHE: "Why don't they teach the alphabet to children in school any more?"

WISEON: "They don't need to!"

SHE: "Why?"

WISEON: "They learn it by listening to WRNY, WEAF, WOO, WIP and other stations.—*Hymen Bushlowitz, Rep. No.* 25,789.

BUT THE MOTHER-IN-LAW DOESN'T FADE OUT

Why is an amateur broadcasting station and a mother-in-law alike?

Ans.: Because they are both generally in the air and cause a lot of local interference.—*John J. Cavanaugh.*

THROW IT IN REVERSE

What is the difference between a home-made radio and a Ford?

Ans.: With the radio you buy the parts and assemble it. A Ford you buy assembled and drive it home and you have the parts.—*John J. Cavanaugh.*

NO DOUBT—NO DOUBT

(In chemistry class).

PROFESSOR: "What is the most deadly poison known?"

BRIGHT PUPIL: "Embalming fluid! You're dead before it touches you."

HOPE THERE IS NO Q.R.M.

A young civil engineer, in preparing to leave for the tropics, simply included two extra suits of heavy woolen underwear in addition to that which he wore. Upon reaching his destination, he rushed madly to the nearest available wireless telegraph station, and to his young bride a message bore the following: S.O.S. B.V.D. C.O.D. P.D.Q. !!!!—*Burton L. Oliver.*

TRY ME ON A GIN-FIZ

1ST MAN: "You're a Fizzle!"

2ND MAN: "Why so?"

1ST MAN: "You were 'lit' the other night and didn't explode!"—*Lorraine Isenhath.*

First Prize $3.00

TRY TRY AGAIN

TEACHER (In biology class): 'Now tell me how one could distinguish between a poisonous and a non-poisonous snake?"

PUPIL: "By its bites!" — *Mrs. Mildred MacAllister.*

WE ARE IN THE SAME CLASS

NEW EFFICIENCY EXPERT: "My man, never be an ohm, always be an ampere—"

WISE CLERK: "I'm afraid I don't draw enough."—*J. Dodge.*

WE receive daily from one to two hundred contributions to this department. Of these only one or two are available. We desire to publish only scientific humor and all contributions should be original if possible. Do not copy jokes from old books or other publications as they have little or no chance here. By scientific humor we mean only such jokes as contain something of a scientific nature. Note our prize winners. Write each joke on a separate sheet and sign your name and address to it. Write only on one side of sheet. We cannot return unaccepted jokes. Please do not enclose return postage.

All jokes published here are paid for at the rate of one dollar each, besides the first prize of three dollars for the best joke submitted each month. In the event that two people send in the same joke so as to tie for the prize, then the sum of three dollars in cash will be paid to each one.

MIGHT HAVE BEEN MICE INSTEAD OF RICE

DINER: "Waiter, there's a button in my soup."

WAITER: (Ex-printer) "Typographical error, sir; it should be mutton."—*Clarence J. Peiffer.*

MAN COULDN'T EXIST OTHERWISE

TEACHER: "Do you know why the earth turns on its axis?"

SCHOLAR: "because it doesn't want to be roasted too much on one side." — *Mrs. Ruth L. Thomas.*

FULL OF WIND

FARMER JONES: "Gee that was some wind storm we had down South about ten years ago; one of our old red roosters was sitting on the grindstone and it took all his feathers off."

TYER SMITH: "That's nothin'. One year back home when I had my corn in a bin, the wind sucked it through a knot hole and shelled it all for me."—*Kenneth Tomlinson.*

WHY SOME?

FIRST DOCTOR: "I wonder what makes some men light on their feet?"

SECOND DOCTOR: "Well, you see, some are full of gas, and others are hot headed and go up in the air very easily."—*John Schnapp.*

CORRECT JUDGING BY WHAT WE SEE!

FRESHMAN: "Perry has brokn the radio record."

JUNIOR: "Sure they're making them radios more like phonographs every day."—*Vivian Keith.*

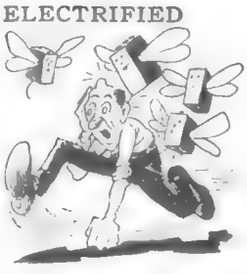
THEY SHOULD MAKE THEIR OWN

Johnny had his mother's dishpan and an old spoon with which he was making quite a noise.

HIS SISTER: "Johnny, what are you doing?"

JOHNNY: "Oh, shut up, sis, I'm making thunder for the lightning bugs."—*Harold Dawson.*

BUT NOT ELECTRIFIED



RADIO NOVICE: "Are these good 'B' batteries?"

CLERK: "Wonderful. A man came in the other day and claimed he was stung with them."—*J. R. Stewart.*

THE PROF. OUGHT TO READ S. & I.

PROF. IN MED.: "How many humors do you know?"

FIRST STUDENT: "Two."

SECOND STUDENT: (reading SCIENCE AND INVENTION) "Three."

PROF.: "What! Name them."

THE STUDENT: "Aquaeous humor, Vitreous humor and the Scientific humor before your eyes."

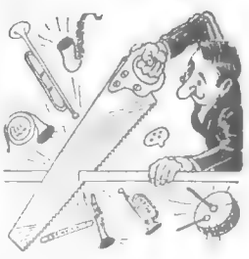
PROF.: "Great! A new discovery!"—*M. Paguia Santos.*

IT USED TO BE A DAY IN FEBRUARY

MAD POET: "Oh, what is so rare as a day in June?"

MEDICAL STUDENT: "Arterio-sclerosis of the umbilical cord."—*Earl Floathe.*

KEEPS TIME WITH A BUZZ-SAW



SON: "Say dad, there's a feller that plays on a musical saw What kind of a saw does he use?"

DAD: "Well, I guess he must have a band-saw or maybe a jig-saw."—*Kenneth Smith.*

JIMMY—LEAVE THE ROOM

A teacher was giving a lesson on the circulation of the blood. Trying to make it clearer, he said:

"Now children, if I stood on my head, the blood, as you know would run into it, and I should turn red in the face."

"Now Jimmy," continued the teacher, "How is it that when I'm standing on my feet that they don't get red?"

"Why Sir," answered Jimmy, "because yer feet aint empty."—*William Anthony.*

THE ORACLE

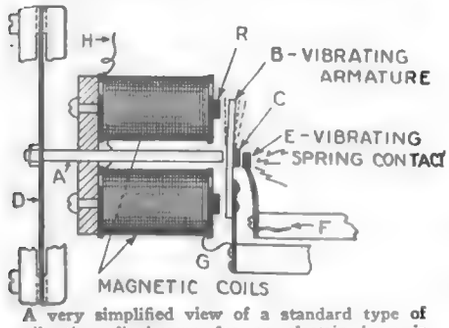
The "Oracle" is for the sole benefit of all scientific students. Questions will be answered here for the benefit of all but only matter of sufficient interest will be published. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink; no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addressed to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 50 cents is made for each question. If the questions entail considerable research work or intricate calculations, a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

ELECTRIC HORN

(2036) Q. 1. John Woodruff, Brooklyn, N. Y., asks: How does the vibrating type of electrically driven horn operate? Kindly show a diagram explaining the action.

A. 1. We are giving the diagram here. It will be seen that this device differs very little from a standard electric bell in its action. However, instead of having a clapper that acts upon a bell, the vibrator is connected by means of a loose link A, to a diaphragm D. As the armature B vibrates, it rapidly strikes the end of the link A and vibrates



A very simplified view of a standard type of vibrating diaphragm for an electric horn is shown above. The various letters on the drawing are referred to in the text.

the diaphragm. It will be seen that the electrical circuit through this instrument is very simple. Entering at H, the current passes through the two magnetic coils, the vibrating armature B, the contact point C, to the other contact point E and out at F. By doing this, the magnets are energized and the armature is attracted. As soon as this happens the circuit between C and E is broken, and the armature immediately returns, only to repeat the operation many times per second. At its vibration the link A is struck by the armature and an impulse is given to the diaphragm D.

FORCE

(2037) Q. 1. John R. Dye, Indianapolis, Ind., says: It is said that force is that which propels an object through space. Therefore, what I want to know is, when a rock is thrown through the air, does the force follow behind it or does it leave the rock as soon as the rock leaves the hand?

A. 1. Force is that which can act against resistance along a path through space. When a rock is thrown, force acts upon its resistance due to inertia and thereby develops energy which is absorbed by the rock. The rock gradually parts with its energy owing to the resistance of the air and to gravity.

Q. 2. How is carbon tetrachloride made?

A. 2. Carbon tetrachloride is made by passing dry chlorine through carbon disulphide in which a little iodine has been dissolved. This produces a mixture of carbon tetrachloride and sulphur monochloride, and by distillation, the carbon tetrachloride passes off and is condensed.

LAW OF MOTION

(2038) Q. 1. Mark Costello, Bronx, N. Y., inquires: What is the third law of motion?

A. 1. Briefly stated, it is as follows: To every action there is an opposite and equal reaction.

RECTIFIERS

(2039) Q. 1. Arthur Fassio, Detroit, Mich., wants to know: Can alternating current be changed to direct current and what are some of the methods of accomplishing this work?

A. 1. There are several ways to change alternating current to direct current by means of rectifiers such as rotary converters and vacuum tube or chemical rectifiers. Several of the latter type have been discussed in the pages of this magazine and we would suggest that you refer to the September and December 1925 issues. In the first mentioned issue you will find several types of rectifiers that are designed for converting A.C. into D.C. for supplying the "B" potential for radio sets and in the December issue is a high voltage rectifier for use in a radio transmitter.

PERMANENT MAGNET

(2040) Q. 1. George W. Morton, Bentonville, Ark., asks: How can I permanently magnetize a four inch long steel bar so that it will be in a saturated condition?

A. 1. The best way to accomplish this work is to insert the steel bar in the center of a solenoid which is connected to a source of direct current and which current is interrupted intermittently. For the size bar you mention, a coil made up of 400 turns of No. 20 D.C.C. wire wound on a 5-inch brass tube may be employed in connection with a 6-volt storage battery. Make one connection solidly to one storage battery terminal and tap the other terminal with the other connection. Allow the current to flow through the circuit fifty times or more in periods of about one second and you will find that the steel bar within the core will be strongly magnetized.

NON-RUSTING STEEL

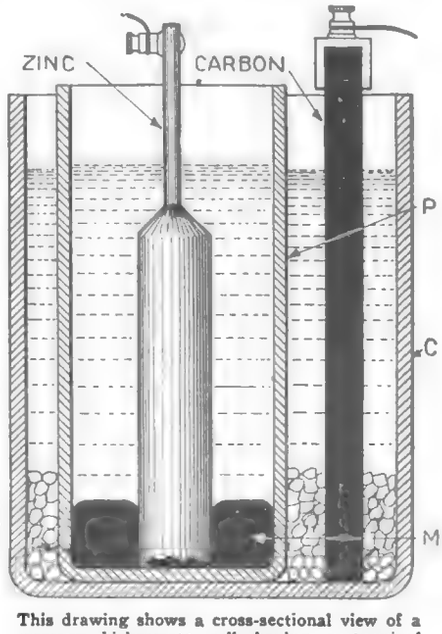
(2041) Q. 1. Richard Henderson, Butte, Mont., asks: Where can a steel suitable for use in rifle barrels, yet a kind that will not rust be obtained?

A. 1. The name and addres of the company supplying this material will be furnished upon receipt of a stamped self-addressed envelope.

MERCURY BICROMATE CELL

2042) Q. 1. George O'Hara, Woodland, Idaho, asks: How is the mercury bicromate cell credited to Fuller constructed, and what is the chemical reaction within it?

A. 1. A cell of the type mentioned is shown in the diagram appearing in these columns. It consists of a zinc electrode placed within a porous cup, the lower end of the electrode resting in a small amount of mercury. The porous cup rests in a larger but non-porous cup and between the two containers is a carbon electrode and another solution. The



This drawing shows a cross-sectional view of a mercury bichromate cell having a terminal voltage of 2 volts.

wire connecting the zinc elcetrode to the outside circuit is insulated so that it does not enter into the action of the cell. The solution used within the porous cup and around the zinc is either a solution of common salt, NaCl, or dilute sulphuric acid. Outside of the porous cup but within the non-porous container, a solution in water of chromium peroxide, chromic acid, is placed. A quantity of the crystals is placed on the bottom of the outside container so as to maintain the saturation of the solution.

In the diagram, M indicates mercury, P, the porous cup and C, the exterior container.

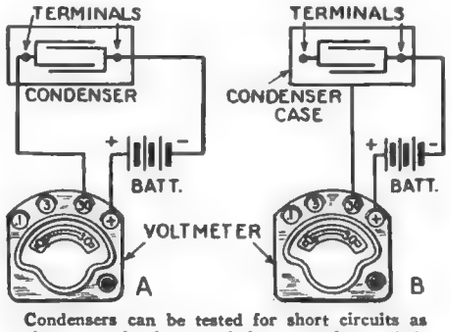
A cell of this type has a terminal voltage of about 2 and is capable of producing a fairly strong current for a short period of time.

The chemical reaction, which takes place in this battery is represented by the following formula:

$$3Zn+2CrO_3+6H_2SO_4=Cr_2(SO_4)_3+3ZnSO_4+6H_2O.$$

CONDENSER TEST

(2043) Q. 1. Richard Sharpe, Toronto, Ont., Canada, asks: Please show a simple way whereby



Condensers can be tested for short circuits as shown at A above and for grounds to their metallic cases as shown in the circuit at B above. Both of these tests are accurate and are simple to make. A pair of phones might be substituted for the voltmeter, and a "click" test made.

metal-cased condensers of the type used in low voltage filter circuits can be tested for short circuits between the two terminals or between either one of the terminals and the metallic case of the condenser.

A. 1. The diagrams given here will show how this can be accomplished. A battery and a voltmeter are connected in series with the condenser under test and if the condenser is not short-circuited or broken down, no indication will be noticeable on the voltmeter. If, however, a short-circuit is present the voltmeter will register. The diagram A shows how short-circuits between terminals are detected and that given at B shows the connections for testing for short-circuits between the condenser case and one or the other of the terminals.

AQUARIUM

(2044) Q. 1. Joseph L., Binder, Harrison, N. J., wants to know if in constructing an aquarium, is it permissible to line the bottom with sheet copper?

A. 1. This is a point that we desire to draw to the particular attention of our readers, especially those who are interested in the article detailing the construction of an aquarium which appeared in the Constructor Department of this magazine in the March issue. In this article it was stated that copper sheeting was used for the covering of the bottom of the tank. If such material is used, it should be given a heavy coat of black asphaltum varnish. Two coats are preferable. If this is not done, copper compounds will be formed in the water which will be fatal to the fish. In some aquariums all the copper parts are heavily nickel-plated. This information was kindly brought to our attention by Mr. Sam Y. Caldwell.

WATER-PROOFING ROPE

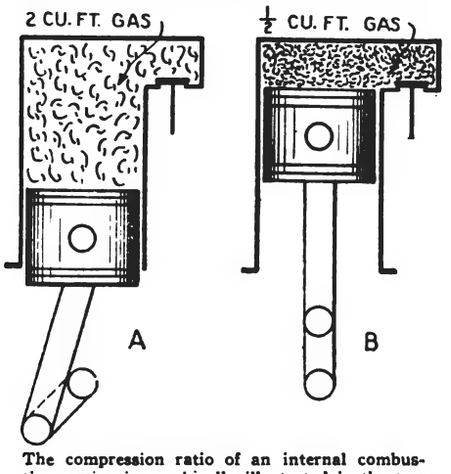
(2045) Q. 1. John Lawson, Meeting Creek, Alta., Canada, has been using a mixture of paraffin and asphalt for impregnating ropes so as to make them water-proof. He objects to the discoloring effect of the asphalt and asks what material can be used in place of it and in connection with paraffin wax in order to make the latter mentioned material less brittle.

A. 1. Probably the very best material for you to use to mix with paraffin wax in order to obtain the desirable results is white vaseline. By varying the relative quantities of the two materials, any desired consistency can be obtained and the result will not tend to discolor the rope as happens with asphalt. Of course, the vaseline will be somewhat more expensive than the material of the former treatment, but the results will undoubtedly be worth it.

COMPRESSION RATIO

(2046) Q. 1. Phillip Seibel. Elizabeth, N. J., asks: What is meant by the automotive term, compression ratio?

A. 1. This term is applicable to any type of internal combustion engine and may be readily grasped by referring to the illustration given in these columns. If for instance just as the intake valve of an internal combustion engine has closed, as at A, there are two cubic feet of gas in the



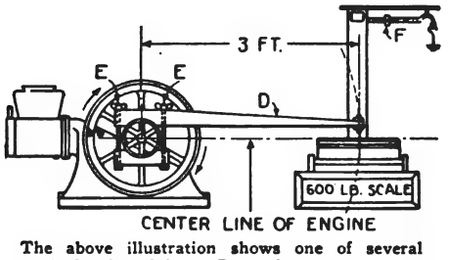
The compression ratio of an internal combustion engine is graphically illustrated in the two drawings A and B above. In this particular case, the compression ratio is 4 to 1.

cylinder, and if after the piston reaches top dead center as at B, there is one-half cubic foot of gas present, the compression ratio is said to be 4 to 1. From this it can be seen just how the superchargers that are now in use on airplanes and racing engines function. If the pressure at the intake valve is increased, there will be a greater pressure of gas in the cylinder when the piston is in the position shown at A and, therefore, the resulting compression when the position B is reached will be correspondingly greater. Since it is known that the explosion pressure or the power delivered to the piston by the explosion of the gas in the cylinder increases as the compression increases, up to within the limits of the type of engine used, it will be seen that any factor which tends to increase the pressure of gas, when entering the cylinder of an internal combustion engine will also increase the resulting power delivered by that engine.

PHOTOSPHERE

(2047) Q. 1. A. E. Zamler, Jacksonville, Ill., asks: What is the photosphere of the sun?

A. 1. This is a brilliantly luminous envelope or layer of luminous vaporous matter that surrounds the central body or nucleus of the sun and which gives the sun the appearance that it has when viewed from the earth. It is in this photosphere or luminous surface of the sun that the sun spots appear. Because of the brilliancy of the photosphere, the sun spots appear to be very dark and resemble great cavities in the surface of the sun.



The above illustration shows one of several methods of applying a Prony brake test to any type of engine. The calculations involved in this work are explained and an example is given in the accompanying text.

PRONY BRAKE TEST

(2048) Q. 1. Robert Robinson, Emison, Ind., asks what is meant by a Prony brake test and how it is made.

A. 1. A Prony brake test is as the word "brake" in its name indicates, a test made by applying a brake to a revolving flywheel driven by the source of power to be tested and measuring the force that is applied to an arm connected to the brake by this application. The diagram given in these columns shows a simplified version of a Prony brake test machine. With this device the brake horsepower at any specified speed can be determined in the following manner. The engine is started and run at its maximum speed. The clamp on the flywheel is then tightened by taking up on the bolts E until the engine has slowed down to the required speed or to quote an example, 1,500 R.P.M. It will now be found that the end of the arm D is pressing on the scale C and registering a certain pressure that can be read at F in the particular type of scale shown. Then the following calculations are performed.

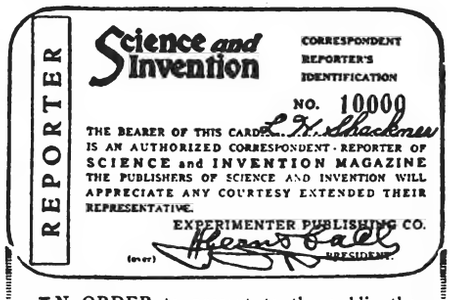
The length of the arm D is known to be 3 feet and suppose that in this case the reading on the scale is 30 pounds. Now it can be seen that the arm D can be considered as the radius of an imaginary flywheel which exerts at its rim a force of 30 pounds. The imaginary flywheel will have a circumference of approximately 19 feet and so it can be seen that during one revolution of the flywheel, the force of 30 pounds will have acted through a distance of 19 feet and, therefore, considering the speed in revolutions per minute, we find that we have a rim speed of 28,500 feet per minute exerting a pull of 30 pounds or in other words 855,000 foot pounds per minute. Since we know that a horsepower is equivalent to 33,000 foot pounds per minute, we find that the engine under test is developing nearly 26 horsepower at a speed of 1,500 R.P.M.

Of course, it must be realized that this is a simplified description of a Prony brake test and in actual practice more elaborate methods are used. This gives the general idea of the proposition.

DISCOVERY OF X-RAYS

(2049) Q. 1. J. W. Murdock, St. Louis, Mo., asks: When and by whom were X-rays discovered?

A. 1. In 1895 while Röntgen was experimenting with a Crookes tube he happened to cover the surface of it with some dark opaque material. When the tube was put into operation by an electric potential applied to the terminals of it, it was noticed that a prepared chemical screen on a table nearby started to glow. There being no other emanations present in the room, further investigations were carried through and it was found that the rays generated within the Crookes tube were penetrating the opaque covering and affecting the screen. From then on, it was only a matter of a short time before other discoveries of the properties of the X-rays such as are well known to us today became public knowledge.



IN ORDER to present to the public the very latest scientific details, SCIENCE AND INVENTION maintains a large staff of field reporters. Any one of our readers is eligible to join this staff and, upon request, a reporter's card will be forwarded, together with complete instructions for gathering material. The reporter's card is illustrated above, and its use will gain admittance to many places that would otherwise be closed to the ordinary person. You need not have any special ability to obtain one of these cards other than a desire to help others to gain knowledge.

Address Field Editor, SCIENCE AND INVENTION.

Submitted manuscripts cannot be returned unless accompanied by postage.

FLUID GAS

(2050) Q. 1. Gaston J. Russell, St. Louis, Mo., asks: Can a gas be properly defined as a fluid?

A. 1. Yes. A gas is a fluid that does not have a free surface and which will completely fill the containing vessel, regardless of how large that vessel may be, expanding with reduction of pressure.

TEST FOR GOLD

(2051) Q. 1. Edward Ross, Chambersburg, Penna., asks: How can I test for small quantities of gold in a solid?

A. 1. To test for very small quantities of gold in a solid, melt that solid, adding three times by weight as much pure silver. Also, place a slight quantity of borax in the crucible. Allow the alloy to cool and solidify and then place in nitric acid. Most of the metal will be dissolved and the remainder will be gold which can be weighed.

Q. 2. What is a good test for mercury?

A. 2. To test for mercury, heat the substance which is supposed to contain that metal in a test tube together with an equal quantity of dry sodium carbonate. If mercury is present, small bright beads will accumulate on the sides of the tube. If it happens that the mercury in question is in a solution, pour some of the solution on a polished copper sheet and if mercury is present, the surface of the copper will turn white or silver color.

GAS EXPANSION

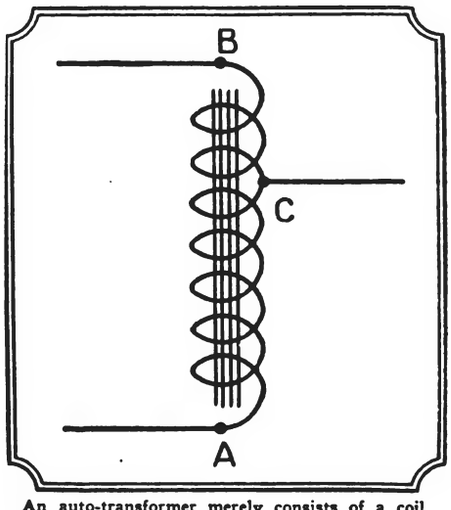
(2052) Q. 1. Robert Dugan, Minneapolis, Minn., asks: In what ratio does the volume of air increase as the temperature rises?

A. 1. Air and practically every other gas increases about 1-273rd of its volume at 0° Centigrade per degree rise in temperature.

AUTO-TRANSFORMER

(2053) Q. 1. R. L. Anderson, Syracuse, N. Y., desires some information regarding auto-transformers, together with a circuit showing how this type of instrument differs from an ordinary two coil transformer.

A. 1. In an auto transformer, sometimes called a single circuit transformer or compensator, only one coil of wire is used. It is wound on the usual iron core and is tapped at some point throughout its length as is shown in the diagram given here.



An auto-transformer merely consists of a coil of wire tapped at some point throughout its length as illustrated above. The ratio of transformation is governed by the position of the tap shown at C.

The primary and secondary circuits of an auto-transformer can be considered, when electrically speaking, as being the same as they are in the two circuit transformer. Externally, of course, they are entirely separate as can be seen in the diagram.

In the particular transformer under consideration, let us consider that the coil AB is the primary, or the coil that receives the incoming current and AC or CB the secondary. If an alternating current is fed into the primary, a magnetizing current will flow in the winding, setting up an alternating flux which will link every turn of that winding and induce therein an alternating voltage. Therefore, we have a voltage in the coil AC or CB and the secondary will deliver a voltage proportional to its relationship to the coil AB. By varying the point C, various voltages may be obtained from the secondary. The voltage obtained from the secondary of a transformer of this nature may be found in the following manner. Impressed voltage is to secondary voltage as the number of turns in coil AB is to the number of turns in the coil AC or CB. Auto transformers are used to step potential up or down in value.

OHM'S LAW

(2054) Q. 1. Robert McCann, Philadelphia, Pa., says that he always has difficulty in remembering Ohm's law for calculating the resistance of a circuit or the amount of current that can be

FIG. 1 FIG. 2

Figs. 1 and 2 above show simple methods of remembering the fundamentals of Ohm's law governing the voltage, current and resistance in an electrical circuit.

passed through a certain resistance by means of a certain voltage.

A. 1. Undoubtedly the simplest method of doing this is to use one of the two figures given in these columns. Here the formula is given in one certain form and this is the only form that is necessary in order to remember the three equations. With either of these methods, it is only necessary to cover up with one finger the single letter to be placed by itself on one side of the equation and the remaining two letters will show the position which the letters on the other side of the equation are to occupy. In this method, E stands for voltage, I for amperage and R for resistance. For example, suppose in Fig. 1, we cover up the letter E. The remaining figures then represent I multiplied by R. Suppose we cover up I. The remaining letters visible denote that I is equal to E divided by R. The same process applies to the form shown in Fig. 2.

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Place a very small amount of this powder on the back of your hand and blow it into the air, and everyone in the room or car will begin to sneeze without knowing the reason why. It is most amusing to hear their remarks, as they never suspect the real source, but think they have caught it one from the other. Between the laughing and sneezing you yourself will be having the time of your life. For parties, political meetings, car rides, or any place at all where there is a gathering of people, it is the greatest joke out. **Price 10c or 3 for 25c**

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Box contains 12 eggs. When lit with a match, each one gradually hatches itself into a snake several feet long, which curls and twists about in a most lifelike manner. **Price per box 10c ppd.**

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To Conquer Arctic on Wings

By WILLIAM P. SULLIVAN

(*Continued from page* 13)

nections are situated in such a manner as to prevent any obstructions such as snow or ice interfering with the working of the system.

PROTECTING OIL SYSTEM AGAINST COLD

The next problem is the oiling system, which, especially in the case of air-cooled motors, must be well designed. The oil tanks are placed under the cowling at the rear of the motors and are constructed of brass and have a thick layer of asbestos held tightly to them by doped fabric. The oil lines also are covered with asbestos and wrapped with fabric throughout their entire length. This protective coating of asbestos retains the heat in the oil and prevents it becoming chilled by the extreme cold; such chilling would prevent it from flowing from the tank and through the lines to the motors. The motors, carburetors, magnetos and all controls are cowled in as much as possible for protection, leaving only the ends of the cylinders exposed for maintaining the desired motor temperature throughout the flight.

POWERFUL RADIO FOR POLAR PLANE

For communication with the mainland full radio transmitting and receiving equipment is carried. A 50-watt transmitter of the Hartley circuit with crystal control operating on two wave-lengths of 45 and 60 meters respectively using a 50-watt W.-E. No. 1818 tube, is installed in the canopy-like section of the wing above the cockpit; the set is suspended from rubber cords to prevent vibration. The controls include a filament voltmeter, field starting button, field rheostat for controlling filament voltage, switch and code sending key, all installed on brackets from the windshield within easy reach of observer or pilot. The power for operating the set is furnished by a wind-driven generator, situated on an extension bracket at the side of the fuselage, directly in the slip stream of the propellers. The antenna is the standard reel type situated at the side of the cockpit, the braided copper wire running down through the floor of the cockpit through a fibre tube where a fish-shaped lead weight is attached to a swivel connection at the end. Direct communication can be carried out between the plane and its base, either from the air or at a landing place, enabling the men on the mainland to know the plane's position and progress throughout the trip.

In case of a landing for exploration, repairs or accident to the plane, enough provisions and equipment in the form of rifles, ammunition, stoves, et cetera, are carried to sustain life for at least two years, seal and polar bears being known to exist as far north as the pole.

Contents for May Issue of Radio News

Changes in the Polarization of Radio Waves
By Greenleaf Whittier Pickard

A New 110-Volt Filamentless Tube
By A. N. Lucian, Ph.D.

The New B-6 Donle Detector
By H. P. Donle

How Radio Tubes are Evacuated
By Dr. Charles B. Bazzoni

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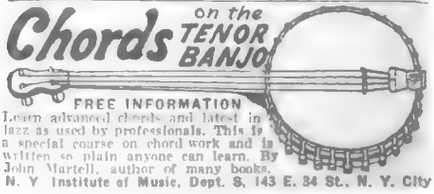

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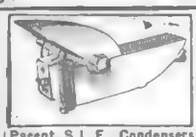

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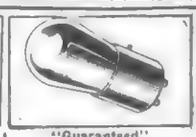

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We consider the "Guaranteed" tube one of the best on the market. Any tube replaced if defective, providing filament lights

Calibrated curve goes with each tube.

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Y799 3 volt. .06 amp. 1.25

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This is the famous Pacent Audioformer. Nickel case is grounded to base. Extra high degree of amplification. Minimum distortion and reaction. Binding posts and solder lugs. Ratio 3½ to 1.

Y2811 Mounted type $4.50

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No better Transformer made. Highest class materials. Impregnated coils Silicon steel stampings, used. Save 50 per cent by assembling it yourself.

Y1100 Ratio 4½-1 $1.40

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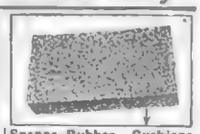
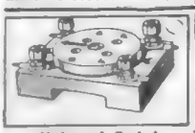


Sponge-Rubber Cushions

Get rid of tube noises due to vibration. Softest sponge rubber made. Size 2¼"x3", ⅜" thick.

Y8989 Sponge-rubber cushions, each ..... $.12

Six for 0.60



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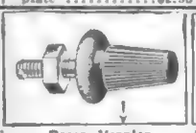

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Why use a vernier dial when a vernier attachment will do anything and everything a vernier dial accomplishes? Cleverest vernier made. Can be used with any dial. Soft rubber ring engages dial. Nothing to come apart.

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Made of sponge rubber. Make wearing your receivers a pleasure. Positively exclude all noises and make reception a pleasure. Sponge rubber will last for years. Light as a feather. Sanitary.

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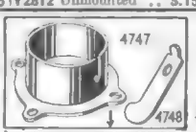
Made in blue enamel and gold, to be worn in button hole. Every radio fan wants one. ¾" diameter. Best gold plate. Perfect reproduction of radio dial.

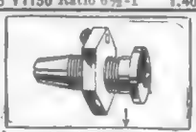
Y7799 Dial Button, Each $0.25



Vacuum Tube Shell

Nickel plated shell for the man who builds his own. 4 holes to attach to subbase. Each shell comes complete with 4 phosphor bronze socket contacts. See illus. 4748.

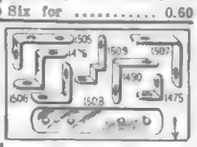
Y4747 Vacuum Tube Shell and Contacts $0.16



Cord Tip Jack

Takes place of binding posts. Cord tip firmly gripped by jack. Made of brass, nickel plated. Screw to attach lead wire. No soldering necessary.

Y1500 Cord tip jack, Each ..... $.15



Brass Nickeled Brackets

All Illustrations ¼ size.

Y1505 Bracket, each $0.05

Y1507 Bracket, each .05

Y1509 Bracket, each .04

Y1476 Bracket, each .05

Y1506 Bracket, each .05

Y1400 Bracket, each .04

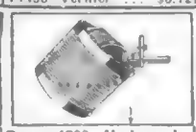
Y1575 Bracket, each .03

Y1508 Bracket, each .05

Microvern

THE vernier dial for extra sharp tuning. No backlash. Special finish permits logging of stations on dial. Beautiful appearance. Comes in gold or silver finish. State which wanted.

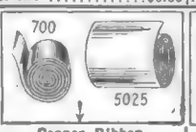
Y3066 Microvern, any finish $1.76



Rasco 180° Variocoupler

Silk wire wound on bakelite tubes. Six taps. Wave length, 150 to 600 meters. For panel mounting, ¼" shaft. Your money refunded if it is not all we claim.

Y3100 Variocoupler prepaid $1.05



Copper Ribbon

.0005" thick.

F700 ¾" wide; F701 ¼" wide; F702 3-16" wide. All sizes per foot ... $0.01

Copper Foil

.001" thick. 4" wide.

Y5025 Copper Foil, per foot $0.10

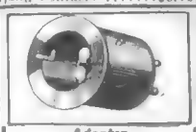
10-foot length 0.80

Rasco Clip Leads

Invaluable for experimental work. Clip lead hooks in a jiffy onto any wire, binding post or conductor. Safest experimental connection. Brass clips, 1 foot silk wire, green or red

Y7887 Clip leads, ea. $.12

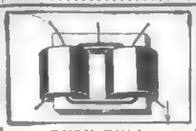
Dozen lot 1.35



Adapter

Pacent Improved Adapter. Takes 199-type tubes. Fits standard 201A sockets. Phosphor bronze springs, short circuits impossible. Bakelite molded.

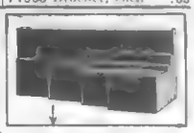
Y6520 Adapter $0.36



PUSH-PULL

Push Pull Transformer for many new circuits See any radio magazine. Made of best materials. Coils impregnated. Silicon steel laminations. Save 50 per cent by assembling yourself. Simple instructions furnished.

Y1159 Push-Pull Transformer, ratio 6½ to 1 $2.95



Hard Rubber Panels

Highest dielectric strength as per Bureau of Standards. Beautiful high finish.

Y7100 7x10x3-16" $0.65

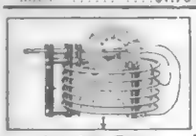
Y7120 7x10x¼" .79

Y7140 7x14x⅛" .89

Y7180 7x18x3-16" 1.15

Y7210 7x21x3-16" 1.31

Y7240 7x24x3-16" 1.46



Low Loss Tuner

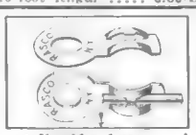
Same type as used in our LOLOS EXPLORER Tunes from 200 to 600 meters. Hard rubber insulation throughout. Silver plated primary. Secondary D. C. C. Tickler silk insulated wire.

Y2690 Tuner $5.00

"T" Wire Connectors

This big little article solves all troubles when making "T" wire connections. Made to take 1-16" square or round bus-bar wire. Can be attached with a pair of pliers

Y2975 "T" Wire Connectors, 12 for $0.10



Nosolder Lugs

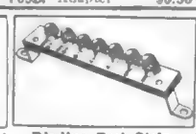
Finally, a real solderless lug is here. Soldering positively done away with. Takes square or round bus bar, which it holds with a vise-like grip. Perfect connection. Just slide bus bar into slip-grip.

Y3727 Lug. 25 for $0.20

Low Loss Coil

Same type as used in Freshman and other Tuned Radio Frequency sets. D.C.C. wire. 200-550 wave-length. 3" diameter. 1" wide. 5-16" thick. 4 connections. 2 primary, 2 secondary.

Y2629 Low Loss Coil $0.40



Binding Post Strip

Made of hard rubber, gold engraved lettering. Two nickel brackets for mounting. 7 hard rubber binding posts. "ANT"; "GND"; "A—"; "A+"; "B"; "DET B+"; "AMP B+".

Y870 Binding Post $0.35

Tinned Nickel Lugs

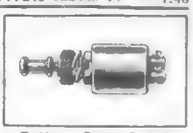
All our lugs are tinned.

Y310 Brass Lugs for No. 8 screw, doz. $0.10

Y311 Copper Lugs for Nos. 6 and 8 screws, doz. 0.10

Y309 Copper Lugs for Nos. 4, 6 and 8 screws, doz. 0.10

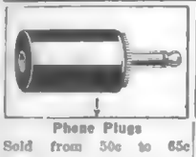
Y309 Copper Lugs for 6-32 screw, doz. 0.10



Battery Snap Switch

This Switch is produced under high standards of workmanship. Action is positive. Solderless contact screws used. One hole mounting. Nickel plated all over. Most serviceable switch made.

Y7986 ..... $0.36



Phone Plugs

Sold from 50c to 65c everywhere. Hard rubber composition shell and patented cord tipholder. Finest workmanship through. out

Y1030 Rasco Telephone Plug. Each $0.23

Bakelite Socket

Octagon shape. Four nickel binding posts, phosphor bronze contact springs. Best brown bakelite.

Y6510 Bakelite socket $0.40

Y6500 Tube Socket Made entirely of composition. Best made. Each .. $0.35

Binding Post Name Plates

Dia. ¾". These styles: Phones, Ground, —, Output, "A" Bat. —, "B" Bat. +, Loud Speaker, "G" Bat. —, Aerial, +; Input, "A" Bat. +, "B" Bat. +, Loop, "G" Bat. +. New! "A" Bat. + "B" Bat. —.

Y6000 Name Plates, Dozen $0.15

"Rasco" Posts

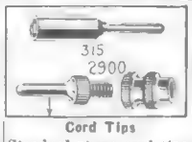
Made of hard rubber composition.

Y650-51 Each $0.06

Y202 Hi. nickel plate bottom, each $0.06

Dozen, each style... $0.70

Y122 Initialed Binding Posts. Set of 8. Per Set $0.25



Cord Tips

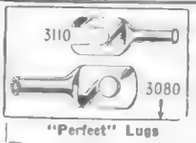
Standard phone cord tips, nickeled.

Y315 Each $0.03

Separable Cord Tips

No solder required. Wire goes in ferrule. Shank holds it tight. Nickel plated.

Y2900 Each $0.06

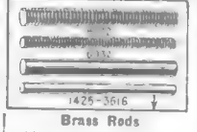


"Perfect" Lugs

These new and improved lugs are brass, nickel plated, flattened on top as shown. Made of a single piece of metal Lead wire goes into tube.

Y3110, Y3080 "Perfect" Lugs. Each $0.02

Dozen lots 0.20



Brass Rods

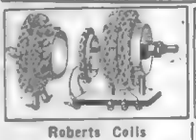
Sold in 6 lengths only.

Y8032 Rod 8-32" thread length $0.08

Y6032 Rod. 6-32" thread length $0.06

Y1425 Rod. plain, ¼" round, length $0.10

Y3616 Rod, plain, 3-16" round, length $0.06



Roberts Coils

Diamond weave coils, used in standard Roberts Circuit. Tunes 200 to 570 meters. Used in 2, 3, or 4 tube circuits. These are genuine Sickles Coils, not imitations. Set comprises two units, as illustrated.

Y-8112, Roberts Coils $5.95

100-Ampere Storage Batteries

Guaranteed for two years. Only new material used. Genuine hard rubber case. Acid-proof terminals. Hard rubber vents Strong carrying handle. Written guarantee goes with each.

Y-9100, 6-volt 100-ampere hour battery ... $9.50

Shipped express collect.

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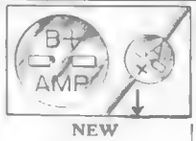
Also Logbook of all Broadcast Stations

Just to name a few of the circuits: The V.T. as a detector and one-step amplifier; all Armstrong circuits; one-step radio frequency amplifier and detector; three stage audio frequency amplifier; short wave regenerative circuits; 4-stage radio frequency amplifiers; radio and audio frequency amplifier; inductively coupled amplifier; all Reflex Circuits

FREE

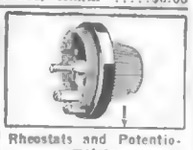
A POSTAL CARD BRINGS IT



NEW Battery Lead Tags

Latest wrinkle, made in metal, nickel-plated, polished. Clamp tag on battery wire, and it won't come off. These five styles: "B +", "B + Det.", "B —", "A +", and "A —".

Y8030 Tags, set of 10 $0.15



Rheostats and Potentiometers

High heat bakelite base Come with tapered, knurled knob, 2½" dia. Complete with pointer.

Y4310 6 ohm $0.38

Y4311 30 ohm 0.44

Y4312 Potentiometer 200 ohms 0.50

RADIO SPECIALTY COMPANY, 100 Park Place, New York City

Factories: Brooklyn, N. Y. Eldridge, Md.

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Edited By
A. P. PECK

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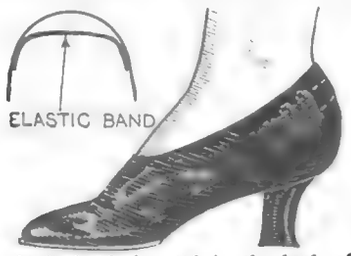
NOTE:—Before mailing your letter to this department, see to it that your name and address are upon the letter and envelope as well. Many letters are returned to us because either the name of the inquirer or his address is incorrectly given.

SHOE DESIGN

(934) Q. 1. Edward F. Pynnyaski, Holyoke, Mass., has devised a system whereby dancing pumps can be kept on the feet without slipping off at the heels. It merely consists of a short strip of rubber band or elastic fastened within the shoe and around the heel as shown in the drawings here. This elastic material will keep a constant pressure against the heel of the wearer and will result in holding the pump in place.



An elastic band, inserted in the back of a shoe as shown in the above diagram is not a worthwhile idea.

A. 1. In regard to your proposed idea for preventing dancing pumps from slipping off the feet, we would advise that the system in its entirety is rather old. A much better and more practical method of accomplishing the same work is to provide a small smooth leather projection directly at the back of the heel. This is done in a good many shoes on the market today and accomplishes its purpose quite effectively. We do not believe that you would be able to realize financially upon a system of this nature, because of the fact that it has been anticipated by many other inventors. In view of this fact, we would not advise you to proceed further.

TRANSMISSION

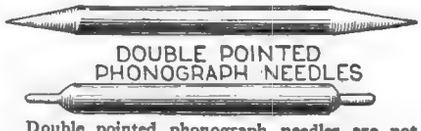
(935) Q. 1. W. B. Marshall, Norwood, R. I., has designed an electric automobile transmission which offers any number of speeds and eliminates the friction clutch and transmission gears in common use today. He claims that it is different from any other electro-magnetic system of gear shift that has ever been devised heretofore, and is desirous of finding out whether or not such a device would be worthy of a patent.

A. 1. A device which will work in the manner you suggest and produce efficient results would undoubtedly be of value. However, we cannot make any more comment upon the practicability of your device than this, unless you can furnish us with details. Undoubtedly a device of this nature would be worth the protection offered by a patent if proven practical.

PHONOGRAPH NEEDLES

(936) Q. 1. Wm. J. Taylor, Nenana, Alaska, sends us a design of two different types of double pointed phonograph needles, both of which are shown in these columns and which are to be made to operate different types of records. He asks our opinion on the advisability of patenting such needles.

A. 1. Double pointed phonograph needles are not to be desired for many reasons. The cost of manufacture can be practically neglected in considering this proposition, but convenience to the user must be considered. When needles are placed in the average holder, they are pushed in quite far and as a result the majority of the points that are not used first will be damaged. Then, when the user attempts to employ the second point, he will find that it does not give good reproduction and there is a likelihood of his spoiling records with the damaged point. We do not consider this idea to be practical or at all worth while and would most certainly not advise you to proceed with attempting to patent it.



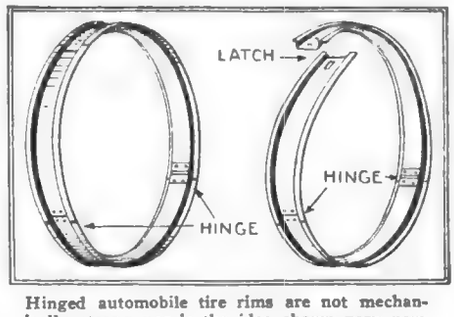
Double pointed phonograph needles are not desirable for the reasons mentioned in the text above.

TIRE RIM

(937) Q. 1. J. M. McManaway, Anderson, Ind., submits a design for an automobile tire rim which is hinged in two places with the idea in mind of making its removal from an automobile tire simpler and easier. He asks our opinion on this type of rim.

A. 1. We do not see any very radically new points in your proposed split rim for automobiles that would make a patent upon the same worth while. Rims of this nature have been designed and patented heretofore, but are not to be desired in split rims because of the effect of weather and other outside sources upon the hinges. Furthermore, the hinges are always weak points and when the average mechanic starts to take a tire off a rim, he has little if any respect for the rim itself. We are sure that in such hands, a rim manufactured as you have designed would not last long.

Frankly, we would not advise you to attempt to obtain a patent upon this rim, as we do not believe that the same could ever be made a financial success.



Hinged automobile tire rims are not mechanically strong nor is the idea shown very new.

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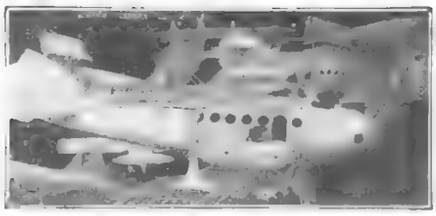

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Problem of a Radio Program Director

By CHAS. D. ISAACSON

(*Continued from page 57*)

should be arranged to present his trios, quartettes, and other chamber music, his symphonic orchestras, his grand opera presentations? Shall they be given without explanation, without setting; or do they need something else which will open the mind, arouse the imagination of the listener, and help to visualize the stage setting?

It is one thing to *plan* to present grand opera, symphonic music, concert programs. The next thing is to find the artists. The big artists are engaged with the opera companies, their contracts forbid them to broadcast. Or if they are not with the opera companies, they are demanding huge fees. What inducements can be offered to bring them to the station, to devote the time to rehearsals and performances? This is where the program director must begin to use his ingenuity.

Then, after the music, comes the theatre. How shall he bring in the theatrical companies, and induce the members of the casts to come up after their heavy performances? What shall be selected from the play, what is good in the play, what is interesting to the listeners?

I am reminded of the statement once made by a public speaker who said: "The reason I object to socialism is not that it divides property and gives a closer and equal division of the opportunity, but because it fails to carry with it a division of responsibility. If socialism will say to me, 'Yes, let us divide property, but let us also divide duties and work,' I would be for socialism to the last degree." Radio listeners can help radio broadcasting and radio development by devising a way of aiding program directors and artists in consideration of the fact that they do not pay for their entertainment.

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The RADIO NEWS Prize Play, "The Hidden Witness," was effectively presented by the Radio Theatre Players, under the direction of Al. Rigali.

In the "Up and Down Broadway" Review, the Yiddish Art Players produced the famous success, "The Dybbuk," in broadcast; "A Weak Woman," "Port of London" and other theatrical successes were given in part by their respective companies.

The Catholic Circle brought Father Wynn; The Jewish Circle, Dr. Lee Frankel; and the Protestant Circle got under way with the Rev. Mr. Megaw.

Many interesting novelties were added on Novelty Night, which included a Lincoln's Day Birthday program, a Poet's Symposium, and the "Presidential Inaugurals." Perhaps you listened in when Texas Guinan and Vincent Lopez and nearly fifty other popular entertainers were on the air.

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I will see you again next month.

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Tarrano the Conqueror

By RAY CUMMINGS

(*Continued from page 37*)

breath of the Arctic in this warm palm-laden garden—swept the horror-stricken crowd.

"Georg, have mercy!"

Maida's frightened, pleading words brought Georg to his senses. He snapped off the cylinder and dropped it behind him to the palace roof-top. He was trembling and white as he stood with his arm around Maida. Weapons so drastic as this one were seldom used. Indeed, it was law throughout both Venus and the Earth that no civilian should possess them. The power for wholesale death in his hand, and which without wholly meaning to, he had so nearly used to its full effect, had unnerved him.

Without the ray, the wind soon died. The warmer air mounting, melted the ice; the snow ceased falling. But the swath of shriveled foliage remained—a hideous scar cut into the luxuriant tropical growth.

. . . a barge of white flowers, its sides lined with maidens to fend off the deluge of blossoms with which the onlookers assailed the bridal couple.

The mob had forgotten its threats, its evil intent. Silent for a moment, it now burst into outcries. Motionless: then milling about, struggling aimlessly with itself—struggling to retreat. A panic of terror. The boats in the lagoon were retreating. The slaans along the fringe of shore began hurriedly to embark. The groups huddled at the palace steps were trying to shove the others back. In a rout they tumbled into their boats and scurried away. Maida's voice, striving to reassure them, was unheard.

And presently the scarred, trampled garden was empty and silent.

The rebellion, checked thus at its start, was quelled. Throughout the city that night—for the slaans to hear whether they would or no—the broadcast stations flung their stentorian tones to the people: a speech by Maida; her promise of better things to come for the slaans; the end of Tarrano's brief rule; a reorganization of past conditions. Maida herself had never been in control in the Central State. The luxury—the license—of the ruling class had been no fault of hers. She promised fair treatment now to the slaans. She was to marry Georg

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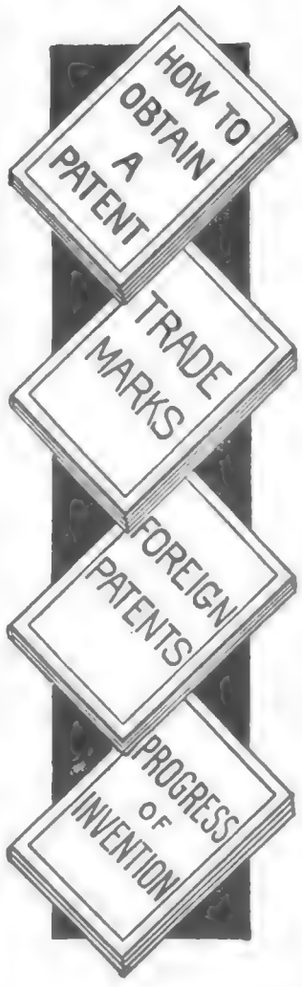

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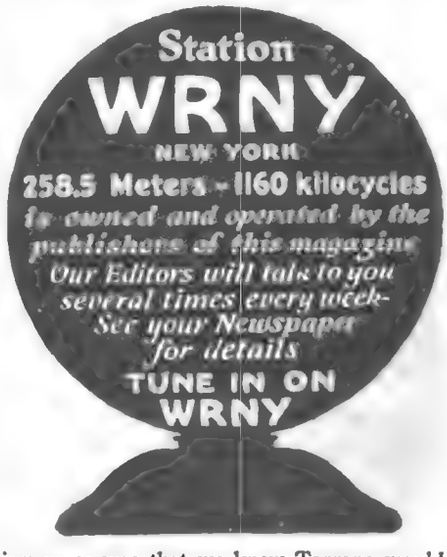
Brende, the Earth-man. Together they would rule the Venus Central State.

Maida did marry Georg. With the many stirring events—a time when disaster and death threatened us all—so soon to follow, I shall not pause to describe the wedding. A quaint, yet magnificent spectacle. Maida in her regal robe; Georg looking every inch a ruler. Their barge of white leading the procession—a barge of white flowers, its sides lined with maidens to fend off the deluge of blossoms with which the onlookers assailed the bridal couple. The arrival at the marriage island, where on an altar the quaintly garbed Holy man immersed them; and the solemn men of law united them as one.

It was a night of rejoicing throughout the Great City; and on every mirror in the Empire it was pictured for those who could not be present.

A time of rejoicing. Yet then—as always those days—my heart was heavy. Elza was held by Tarrano. We knew he had taken her to the City of Ice. There was of course, no radio communication with the Cold Country. We had tried eavesdropping upon it, but to no avail. Tarrano's close-flung barrage checked every wave we could send against it.

Time passed—a month or more. We were worried over Elza naturally. Yet the saving grace was that we knew Tarrano would treat her kindly; that for the present at least, she was in no danger.



Georg and Maida took possession of the Central State. Their rule started auspiciously, for by a series of speeches—a reorganization of money payments—the slaans seemed well satisfied. Loyal, and with a growing patriotism, an eagerness to help in the coming war with Tarrano. Georg—without actually saying so—made them believe that the only hope of everlasting life was the recovery from Tarrano of the Brende model. The model was in the City of Ice; it must be captured.

As a matter of fact, to us of the government, the Brende model was not indespensible. The greatest factor was that the threat of Tarrano's universal conquest must be forever removed. Like a rocket-bomb, this man of genius had risen from obscurity—had all but conquered the three greatest worlds of the Universe.

I think that the height of Tarrano's power was reached that day on the eve of the Water Festival when he made his triumphant entry into the Great City. Venus was his at that moment; all of Venus. Mars was his; the Hairless Men—savages who had fallen readily to his wiles, had conquered the civilized, ruling Little People. And the Earth, over-run by his spies, deluged by his propaganda which, insidiously as rust will eat away a metal, was eating into the loyalty

of our Earth-public—our own great Earth was in a dangerous position. The Earth-Council realized it. The Almighty only could know how many of our officials, our men in trusted positions, were at heart loyal to Tarrano!

The thing was obvious. The assassination of our three rulers—leaders of the white, yellow and black races—with which Tarrano's campaign in the open had begun—those assassinations could never have taken place had not our military organization been diseased.

Facts like these were constantly coming to us now, here in the Great City. A brief time of physical inactivity. Yet underneath the calm, we realized there was a struggle going on everywhere; a struggle of sentiment, of propaganda, of public opinion.

Warfare, with modern weapons by which a man single-handed might destroy a city—is no longer a matter of men. The citizen—unarmed—united in sentiment and desire with a million of his kind—becomes the real ruler. You cannot—because you have a weapon—destroy a million of your brothers.

We realized this. And in the ultimate decision—the popular fancy almost—of our publics—lay our real success or downfall.

Tarrano in the popular mind had a tremendous hold. Dispatches from Earth made it plain that upon every street level the

A cloud! A black cloud—unnatural of aspect somehow—a rolling, low-lying, black cloud . . . "Death, Jac! Death to all the city! The black cloud of death!"

people were discussing him. From the Great City daily we sent bulletins of our progress toward checking—destroying—the menace of him. But bulletins also, were emanating from the City of Ice. We could not stop them. Cut off at every official Earth-station—and with all unofficial stations unable to receive them—nevertheless at some secret station which could not be found, they were received. And from there, circulated throughout the Earth. The air was full of them. Mysteriously, scenes showing the great Tarrano appeared upon the official news-mirrors; a speech of Tarrano's was once officially broadcasted before its source could be located and stopped.

Like a smothered fire smouldering, lacking only a breath of vital gas to explode it into flame, the sentiment for Tarrano spread about the Earth.

Public opinion is fickle. It sways instinctively—not always, but often—to the winning side. Here in Venus we knew we must defeat Tarrano. Destroy him personally and thus put an end to it all forever, since his dominion hung wholly upon the genius of his own personality.

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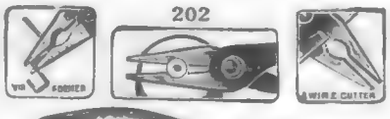

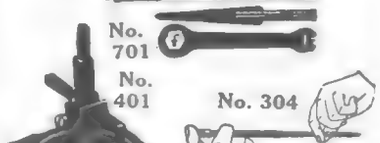

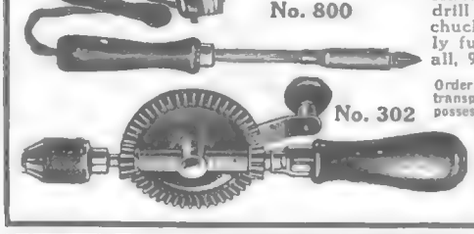

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Our spies, some of them, got to the City of Ice, and back. A few flying men were able to hover about the city, and with instruments peer down into it. We knew that Tarrano was mobilizing for a move upon the Earth, where with a war-like demonstration he hoped to be accepted, yielded to, without a severe struggle. But, within a month now, we learned he had abandoned that idea. He knew, of course, our own preparations to attack him; and he began concentrating everything upon his own defense in the City of Ice.

His last stand. We officials knew it. And we knew he felt it also. And though on Earth our public felt differently, the Little People recognized it. A stirring, wonderful time—that day when on our mirrors was pictured the revolt of the Little People against the Tarrano rule of the Hairless Men. Grim scenes of tragedy; and over the carnage, the Little People triumphed. Tarrano's rule—with all the excesses of the Hairless Men who proved themselves mere rapacious plunderers in the name of warfare—was at an end on Mars.

$11,000 for Spirits

More than two years ago SCIENCE AND INVENTION Magazine offered a prize of $11,000.00 to anyone who could demonstrate his or her ability to communicate with the spirits or to give some definite form of a psychical demonstration which in itself was not trickery.

The result has been that mediums and spiritual organizations have been afraid to place proofs before us. Those weak attempts which have been made to demonstrate psychical phenomena were almost instantly proven fraudulent, and no medium has dared to contradict our findings.

In view of these facts, should we not consider all mediums fraudulent? Should we not consider every psychical manifestation as being trickery pure and simple, intended primarily to fleece those who visit the circle and who find solace in the words from the worst forms of charlatans, namely those who are being permitted to practise upon the poor, seeking words from loved ones?

We have $11,000.00 offered by this publication and Joseph F. Rinn which will be awarded wholly or in part to the one producing a phenomenon devoid of trickery.

The effect on Earth of this Martian reversal was beneficial to us. A good omen. We on Venus, redoubled our efforts to attack successfully the City of Ice.

Mars could send us no aid, though now in full sympathy with us. The planet was daily at a greater distance from us; and the Little People, not recovered from the effects of their own bloody strife, were in no position to help us.

Nor did the Earth-Council deem it wise to send men additional to those few we already had. The Earth was rapidly being left behind by the swifter flight of Venus through her orbit. The official season for the mail-flyers was closed. The opposition of the two planets was long since passed; millions of additional miles were adding to the space separating them.

And the Earth-Council was not sure of its men! Any one of them might secretly be in Tarrano's service—and do us infinitely more harm if brought to Venus, than if left at home.

We seemed of solid strength in the Central State. For the first time in generations the Rhaals—the men of science from whom all the progress of civilization on Venus

came—departed from their attitude of aloofness. Their work—always before industrial—now turned to the sterner demands of war.

The Rhaal City, *....., lay a brief flight from us. A grave sort of people, these Rhaals. Men of square-cut, sober-colored garments; women of sober grey flowing robes—white hair coiled upon their heads. Intelligent women, dignified of demeanor; many of them learned as were the men.

Their city, teeming now with the preparations for war, was intensely interesting to me. We spent most of our days in it, flying back at nightfall to Maida's palace. Yet I shall not describe it, nor our preparations, our days of activity—but hasten on to the first of the extraordinary incidents impending.

It came—this first incident—through my thoughts of Elza. I was worried—more than worried, sometimes almost terrified about her. My instinct would have been to take a handful of men and dash to her rescue—which of course would have been absurd. I tried to reassure myself. Tarrano would treat her kindly. Soon, in full force, our army would descend upon the City of Ice, capture it, destroy Tarrano—rescue Elza.

Rescue Elza! Ah, there lay the difficulty which I never dared contemplate in detail. How would we rescue her? Tarrano would treat her kindly, now during his own security. But if, at the last, he saw his own defeat, his death perhaps impending—would he treat her kindly then?

I loved Elza very deeply. A new torture came from it now. Did she love me—or Tarrano? I remembered the gentleness of the man with her. His dignity, his power—his undoubted genius. And who, what was I? A mere news-gatherer. A man of no force, and little personality. A nonentity. Sometimes as in my jealousy I contemplated Elza with Tarrano now, I felt that he was everything a young girl would fancy. How could she help loving him?

At night, when sleep would not come to me, I would lie tossing, thinking of it. Did Elza love me—or Tarrano? Once I had thought she loved me. But she had never said so.

* *An awkwardly pronounceable word which for the purposes of this narrative may be termed Industriana.*

$5,000 for Perpetual Motion

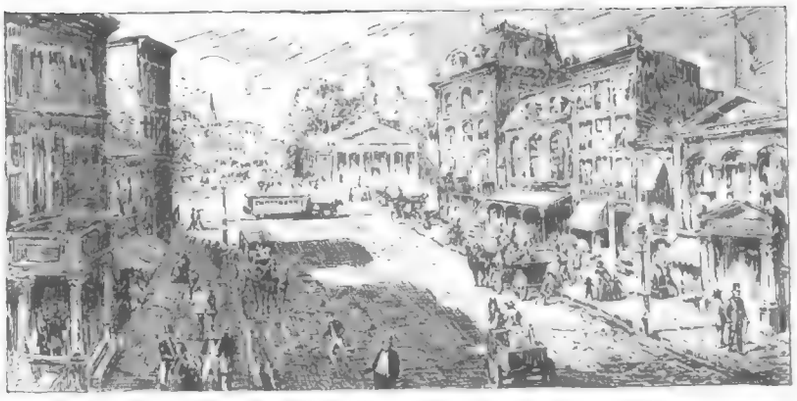
When SCIENCE AND INVENTION Magazine was still in its infancy, the editors denied the possibility of constructing a perpetual motion machine using those forces of nature as we now know them.

Since that time the editors have received thousands of different designs for perpetual motion devices, and have received hundreds of circular letters soliciting finances for the building of perpetual motion machines.

The editors know that if they receive these letters, there are thousands of others in this country who get similar letters and who fall for the claims made in the numerous prospectuses giving the earning capacities of the various machines.

Most of the shares of stock for these perpetual motion machines are being sold at a rate of $1.00 per share, although some inventors are trying to sell shares of stock at $100.00 per share.

Therefore the editors of this publication say, "Just come in and show us—merely SHOW us—a working model of a perpetual motion machine and we will give you $5,000.-00. But the machine must not be made to operate by tides, winds, waterpower, natural evaporation or humidity. It must be perpetual motion."



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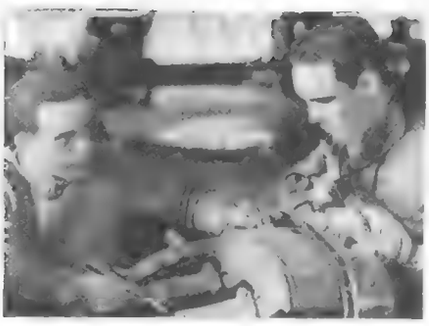

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It was out of this constant thinking of Elza that the first of the incidents I have mentioned, arose. There came to me one night the feeling that Elza was near me. I awoke from half sleep to full wakefulness. In my bedroom, upon the low couch on which I lay, the aural lights of Venus spread their vivid tints. The palace was silent; I sat up, pressing my palms to my throbbing temples.

Elza was coming nearer to me!

I knew it. Not by any of my bodily senses. A knowledge, which suddenly I realized that I had. A moment, and then I was conscious of her voice! No sound; my ears heard nothing. Yet my brain was aware of familiar tones. I recognized them, as one can remember how a loved voice sounded when last it was heard.

But this was no memory. A present actuality; it rang soundless in my brain. Elza's voice. Anxious! Frightened!

At first only the confused *tone* of it. Then the consciousness of words. Two reiterated words:

"Danger! Jac! Danger! Jac!"

I waited no longer, but rushed to Georg and Maida—beautiful Maida in her robe of sleep with her white hair tumbling about her. Georg half awake—yet almost at once he could understand me, and explain.

IMPORTANT

TO NEWSSTAND READERS

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Natural, instinctive telepathy! It had not occurred to me. I had never bothered to develop telepathy; and indeed with any degree of fluency—or even of surity of reception—the phenomenon is difficult to perfect. Yet, as I knew, with a loved one absent upon whom one's thoughts dwell constantly—in time of stress telepathy is occasionally automatically established.

It was so in Georg and Maida's case, back there in the Mountain Station on Earth. Telepathy was the explanation of Georg's mysterious actions as he stood there before the sending mirrors, crossed the room in confusion, and like one in a dream leaped from the window to be seized by Tarrano's spies. Maida had been abducted a moment before. Georg's brain became aware of it. Her danger, the appeal she sent to him.

So it now seemed to be from Elza to me. Georg, out of bed now beside me, urged me to greater efforts of concentration, that I might understand what message Elza was sending.

"Elza! Elza dear! Where are you? What is it?"

I murmured the words to myself as with all my power, I thought them over and over, flinging out the thoughts like radio waves into the night. Mysterious vibrations! In

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an instant, from here—everywhere in the Universe. Who knows their character? Their speed? The speed of light a laggard perhaps beside the flash of a thought! Waves of my thoughts, speeding through the night, with only one receiving station in all the Universe! Would Elza's brain capture them?

"Elza dear! Where are you? What is it?"

"Jac! Danger! Jac! Danger!"

It was very clear. The words rang in my head. But always only those two. And then at last—it may have been an hour later—other words:

"Death! The black cloud of death! You can see it coming! See it coming! Death! To you Jac! To all of you in the city!"

We rushed to the casement. The broad lagoon before the palace lay like a mirror tinted red and purple. Beyond it, palms and the outlines of houses lay dark against the star-strewn sky.

But out there, over the city, in the distance a dark patch obscured the stars. We watched it breathless. A dark patch which soon took shape. A cloud! A black cloud—unnatural of aspect somehow—a rolling, low-lying black cloud. Growing larger; spreading out sidewise; sweeping toward the city on a wind which had not reached us.

"Jac! Jac dear! Danger! Death to all the city!"

Elza's words were still beating in my brain. Soundless words of terror and warning!

"Death, Jac! Death to all the city! The black cloud of death!"

END OF PART II

(*To Be Continued*)

How Movie Films are Edited

By A. P. PECK

(*Continued from page* 14)

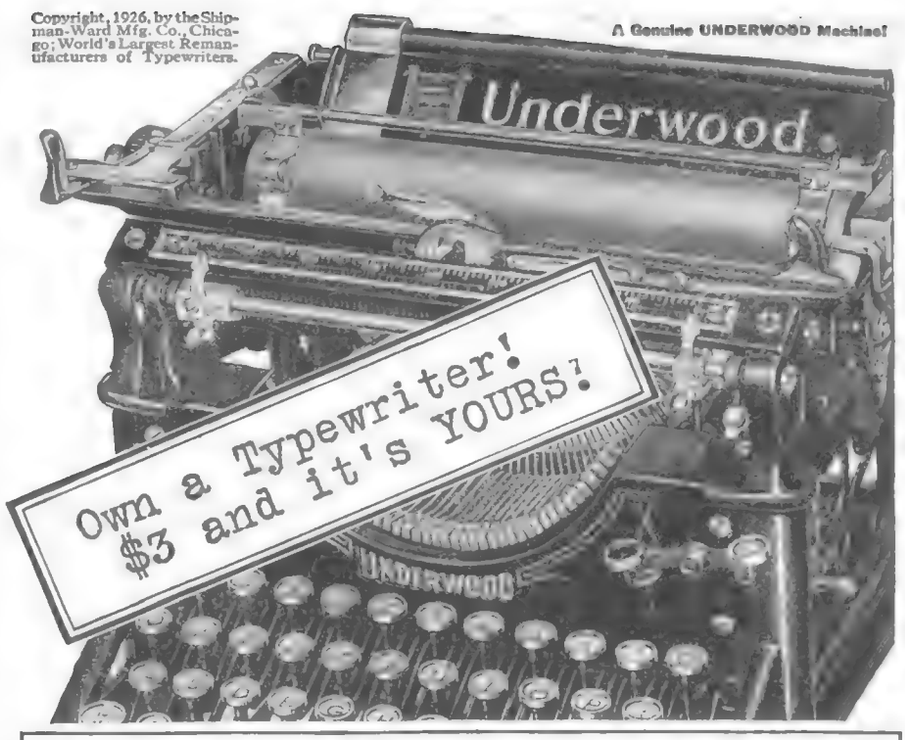
with a number and descriptive term upon it, is held in front of the camera so that it is recorded on the next few frames, and this number forms a tie-up with the number on the cards and with the scenario.

Now let us suppose that a film editor starts working upon a certain picture. In the course of time he will view over 50,000 feet of film, but only approximately one-fifth or even less of it must be used. He sees the picture, he reads the scenario and he refers to his cards. After he has viewed all of the different shots taken of any one particular scene, he selects the best two of them and lays them to one side. In this way he goes through all of the films, making two separate divisions, one called "A scenes" and the other called "B scenes." These are for different purposes, but both the A and the B set include a complete series of selections, so that both can finally be edited into finished reels that will eventually be somewhat alike.

After the editor has separated these reels, he starts to piece them together in sequence. Soon it is found that parts must be cut here and there in order to make the action smooth and to keep up the interest. Painstakingly he cuts and cuts again. Then he finds that a certain part of the picture may fit into the sequence better in, say the second reel instead of in the fourth reel as it was originally intended. The change is made and then viewed. The result is more near to perfection. So the work of the film editor goes on. Eventually he has before him a finished sequence of events running smoothly and evenly without repetitions, and with every part logically connected with succeeding sections.

THE SUBTITLES

Then comes another hard part of the work. The film must be cut out again and subtitles inserted. These are usually provided for in the scenario, but the film editor has seen the action in just the same way as the public will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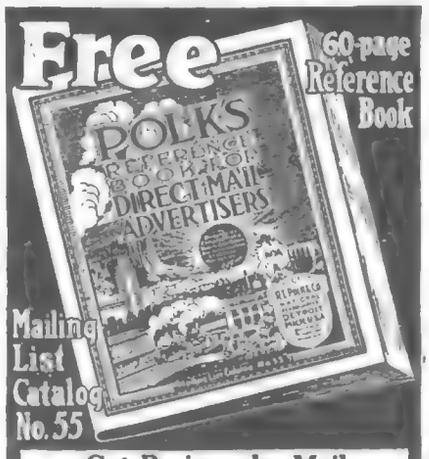

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eventually view it, and he is qualified to make changes in the sub-titles. This he does, always keeping in mind the idea that the action must run smoothly and that everything must be connected, so that there will be no visible break to distract the audience's attention. After the sub-titles have been made, and there are several different forms of them which will be described later, they are inserted into their proper places in the film, cemented in place in the usual manner, and the film is ready for its reproduction into hundreds of reels that will be distributed throughout the conutry.

If the film editor had to view each section of film on a standard screen and if a projection machine had to be threaded and put into operation every time he wanted to see the action, much time would be lost. Therefore, the machine illustrated in Fig. 5 here has been developed and it aids greatly in properly viewing the films. It consists merely of a small motor-driven reel that feeds the film past a gate and a shutter, so that by looking into the eye-piece the editor can see the action just as though he were viewing it on the screen. This machine is quickly set up and can be started, stopped and reversed at will. This is just an exampe of one of the many time saving devices that are employed.

Knowing that our readers would be interested in learning how various types of sub-titles are made, Mr. Tavares was asked various questions and his answers are given in composite form below. Furthermore, the illustrations 1 to 4 indicate how the main types of sub-titles are photographed.

First we have the plain sub-title. The wording that is to convey a certain thought to the audience is printed in a standard form on a card and set up in front of the motion picture camera. A certain number of frames are exposed, the exact number depending upon the length of the sub-title and then this film is developed and cut into the rest of the film in the usual manner. In our illustration in Fig. 1, we have shown a standard motion picture camera photographing this sub-title. Sometimes this sort of apparatus is used, whereas there are other machines that are especially designed for the photographing of sub-titles; they are automatically operated by electricity.

You have undoubtedly often seen sub-titles that are seemingly superimposed upon actual photographs or drawings. In a case such as this, the system shown in Fig. 2 is followed. A photograph or drawing is set up in front of the camera and a certain number of frames are exposed. The film is then wound backward to the point where this object was first photographed and the photo is replaced by a card bearing the sub-title, usually white letters on a black background. The same section of film that was exposed to the photograph is then exposed to this sub-title and when developed, the printing appears superimposed on the still photograph.

COMBINATION SUBTITLES

Then again, we have often seen combinations of sub-titles and motion pictures. In one particular type, the upper half of the screen is devoted to the moving object and the lower half to the words of the sub-title. Just how this is done is explicitly shown in Fig. 3. First, a moving picture is taken of the "action." While this is done, the lower half of the film gate is masked as indicated, and therefore the moving object records only on the upper half of the film. Very often miniature sets are employed for this work as indicated in Fig. 3. Here a miniature train with small, yet life-like scenery is employed to give the proper effect and in the finished picture it appears to be life size. After this exposure has been made, and the correct number of frames have been shot, the film is rewound to the beginning and the mask on the film gate is changed so as to cover the upper half only. Then, the printed

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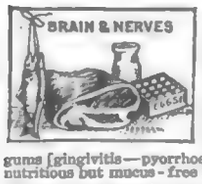

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part is photographed as shown in Fig. 3 and the result is a sub-title that is most interesting and attractive.

The last and probably most charming form of sub-title that we will describe is that illustrated in Fig. 4. The appearance on the screen is a motion picture in full action, but together with this, the sub-title appears directly in front of the moving objects. Although it would seem offhand that such a result would be hard to accomplish, still such is not the case. First, the cameraman goes with an ordinary camera to the location and shoots the action that is desired and which will be illustrative of the sub-title. He grinds out a few more feet of film than will be necessary for the finished sub-title, being sure to do so just for good measure. The film is in this case also rewound and taken back to the studio where the printed sub-title is photographed on the same film with the superimposition effect described above and illustrated in Fig. 4.

Of course, there are other forms of artistic sub-titles than those described, but practically all of them will fall under one of the categories illustrated. For instance, what motion picture fan is not familiar with the live lion that is the trademark of one of the large film companies? The moving picture of this lion usually appears within a circled border and below this is a sub-title or title of a film. Everything on the screen at the time of showing this is still, with the exception of the lion, which is in motion. This is merely another case of double exposure using masks. Either the lion may be photographed first with a mask, having only a circular hole in it and then the sub-title or border may be exposed or the process may take place in the opposite direction, recording the sub-title and border first and then the moving lion. With the present day methods of training wild animals, the correct posing of a lion for this film is nothing unusual.

Often sub-titles are thrown on the screen and flames appear to be playing from the bottom of the screen up across the sub-title. These are produced in several ways, one of the most usual of them being to have a shallow trough of inflammable liquid placed parallel to the card bearing the printing of the sub-title and between it and the camera, but, of course, out of the range of the camera lens. The liquid is then ignited and the flames playing upward between the lens and the sub-title give the desired effect. Many other variations will be obvious.

In some cases, in making combination sub-titles where either still or moving objects are used, together with the sub-title lettering, two films are made. One is exposed to the pictorial subject and the other to the wording. They are then placed together in a special printing machine and by means of what is known as the double printing process, they are photographed simultaneously on a single film. This process is often used both because of convenience and because it is sometimes possible to obtain more sharply defined lettering in the sub-title where such an effect is desired. Furthermore, it is not necessary in this process to wait for one filming to be finished before the rest of the sub-title is photographed. They can be done simultaneously and at a distance from each other and then the two films brought together and double printed on a single strip.

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Answers to Scientific Problems and Puzzles

(*Continued from page 38*)

THE TURN-TABLE

WHEN the bricks are held at arm's length they are moving in a larger circle than when they are brought closer to the center of the table. On account of their inertia they tend to maintain the same velocity when lowered to the side of the body that they had when held out straight. But if they tend to move in a smaller circle with the same velocity that they possessed in the large one, their rate of rotation must be increased. The result is a sudden increase in the rate of rotation of the whole platform. If the arms are again raised the opposite effect is observed and the platform turns more slowly.

THE JACK-O-LANTERN

The action of the apparatus is somewhat as follows: The battery A heats the filament, F, to incandescence, thereby causing it to throw off electrons which are then attracted to the positive plate, P, of the vacuum tube. They then pass around the rest of the plate circuit, through the relay magnet, R, thru the battery, B, and then back to the filament. Thus they constitute a negative current which flows continually through the relay magnet. This current magnetizes the magnet in the relay and tends to draw the armature of the relay until it strikes the contact, M. This spring, S, should be adjusted until it is just loose enough to permit the magnet to hold the armature away from contact, N. If now a negatively charged rod be brought near the lantern, and hence near the grid wire, G, a negative charge will be induced upon the grid which lies between the filament, F, and the plate, P, of the tube. This negative charge on the grid repels the electrons from F and thus reduces the current through the plate circuit and through the relay. If this current is sufficiently weakened, the relay will release the armature enough to permit the spring, S, to draw it against the contact, N. If the wire, L, is connected to M, it is evident that the light will be on until the rod is brought into action, whereupon it will go out. But if the wire, L, is connected to N, the light will be off until the rod is excited and brought near and then the light will go on.

THE SLIDING BLOCKS

Experiment shows that the frictional resistance offered to the sliding of one object over another is proportional to the area of the portions in contact and to the pressure holding the surfaces together. In position, A, the effective weight of the block is pressing on a small surface of contact and the pressure (force per unit area) holding the surfaces together is relatively high. In B, on the other hand, the reverse is true. The area of contact is relatively larger than it is in A, but the pressure is correspondingly reduced. The net result is that the frictional resistance is the same in each case and the block will slide just as readily in one position as in the other.

EVAPORATION TOY

Before water is applied to the wick on bulb, A, the temperature of the vapor in both bulbs is the same. The drop, E, will then slide down the tube until it reaches some equilibrium position near D. If now the wet wick be applied to the bulb, A, the evaporation of the water from it will cool the enclosed vapor and thus reduce its pressure. The greater pressure of the warmer vapor in B, will force the drop up the tube. As this takes place the vapor in A is momentarily compressed and its temperature and pressure momentarily rise, whereas in B there is an expansion and consequent cooling. Both factors tend to stop the upward

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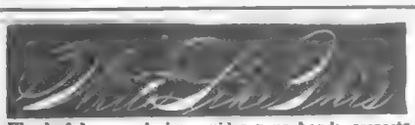

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motion of the drop. As the vapor in A is again cooled by evaporation while the vapor in B regains its normal temperature due to absorption of heat from the air the drop will again descend and the cycle of operations be repeated. Thus it is apparent that it is the heat of the atmosphere that supplies the motive power. But of course it can supply this energy only as long as evaporation takes place. As soon as the water is gone it must be replaced. And if the room were not supplied with additional heat from outside it would eventually be cooled to the point where no more evaporation would take place. Hence in no sense is this a perpetual motion machine.

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Experiment shows us that black objects absorb heat readily and reflect it poorly, whereas white or polished objects absorb it poorly and reflect it readily. If then a thermos bottle is filled with a cold substance a lining of silver between the walls will reflect any radiant heat that might come in from outside and at the same time it will not absorb heat readily so as to conduct it to the interior of the bottle. On the other hand if a hot substance be poured into the bottle the silver lining will reflect back to the interior most of the radiant heat that is liberated by the substance. The efficiency of a thermos bottle is thus increased by the addition of a silver lining to the walls of the bottle.

CLOTHING FOR HOT WEATHER

From the above mentioned facts regarding the absorption and reflection of heat by black and white surfaces, it will be seen that a white suit with a black lining should be an ideal garment for hot weather. The white cloth on the outside will reflect radiant heat from the body while the black cloth will readily absorb body heat and radiate it away.

THE AGILE CAT

A cat turns its body around in mid-air so as to light on its feet by two movements which are executed in quick succession. At first it draws its forepaws in close to its body and extends its tail and hind legs at right angles to its body. At the same time it gives it body a slight twist. The immediate effect of this action is to rotate its head and shoulders in one direction about its longitudinal body axis and its hind quarters in the opposite direction. If its front and rear feet were equally extended no actual rotation of the body would be produced. But by extending its rear legs and contracting its front ones its hind quarters are retarded more than the front portion of the body and the body of the cat is set in rotation. To prevent this rotation from carrying it beyond the desired upright position the cat at the proper moment reverses its procedure. That is, it draws in its hind legs and tail and extends its front paws just as it is on the point of alighting.

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The Human Side of Ants

By PAUL GRISWOLD HOWES

(*Continued from page* 29)

take place will sometimes be strewn with heads and legs and mangled bodies of hundreds of ants. Once one of these insects takes hold it never lets go, unless its head is torn from its body. There is no difference at all between the hand-to-hand methods of ant and man, as far as plain butchery is concerned. War seems to be the inevitable result of community life.

Ants pillage their brothers' cities after a successful battle, just as men do. They rob the vanquished of their hard-earned food stores, and take prisoners, which afterwards actually become slaves.

For the purpose of war, a special caste, known as the Soldier or Warrior ant, has been developed by Nature. These individuals possess greatly enlarged heads and mandibles. In South America the warriors in the tribes of the well-known Army Ant, are indeed formidable antagonists, as the author can attest from several uncomfortable experiences.

MILKING COWS

Perhaps the most remarkable instinct of all which we find among insects, is the universal habit among ants of cultivating and tending their "cows." Ant "cattle" are small, red, green, black or white bugs, known as Aphids, or green fly, as the gardener calls them. These insects breed very rapidly and swarm upon the stems and leaves of plants. They feed upon the plants' sap, which is drawn into their bodies through their sucking beaks. Now, at some time in the remote past, an ant, or ants, stumbled upon a herd of these helpless sucking creatures. In so doing, they discovered that, when bumped into, the aphids exude tiny droplets of a sweet fluid from two tiny tubes at the end of their bodies. This the ants lapped up eagerly, because of its sacharrine nature, and in this act the seed was planted of a habit that has gone around the world and is now the universal privilege of ants.

The tender care of the ants for their cattle is because of the honey that they supply, instead of the milk of our own cattle. So elaborate have the habits of cattle-tending become, that I may but touch upon the subject here. In some cases, houses of paper or wood pulp are constructed over the herds, and guarded by soldier ants, who rush out with open jaws at the first sign of an intruder. Most wonderful of all is the fact that, in the north, the ants carry their herds under ground in winter and place them upon roots beyond the danger of frosts, thus securing a supply of sweets throughout the winter.

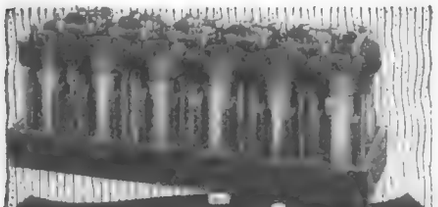
ROBBER ANTS

There are highwaymen in antdom, also. We humans of the big cities are not the only sufferers from the ravages of the bandit and criminal. My photograph shows this quite clearly, and the act of pillage has been neatly caught by the camera. Note the bulldog, not-to-be-bluffed attitude of the robber, and the tenseness of the whole scene, and you will see how human these little insects really are.

Let us now turn back to the Army ant of South America once more, for here we have the most perfect organization in the insect world. We see them advancing through the great forests in a perfect stream, perhaps six inches in width. Like a huge, well-drilled army they advance, ten abreast. There are countless thousands of them, and the great, living, snake-like band moves steadily from morning till night. Think, then, of the myriads that compose these armies!

SOLDIERS WELL DRILLED

Look closely at the uneven places in their ranks, where, perhaps, a stone or fallen



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branch must be crossed. Do the ants surmount the obstacle without a thought for those following behind? No, indeed, here is the spirit of altruism in the army, also! The first to reach the obstacle throw their living bodies into the uneven space. Dozens follow the leader, until the roughness is ironed out with ants, and the rest of the army trudges over a smooth path, built up of their suffering brothers!

Today the command is to march, not to attack, and from wherever that strange command emanates, it is supreme, and not an individual dares to disobey. Tomorrow the command may be to attack and, if so, woe be to anything in the path of these pitiless army ants. They surge through the forest, tearing every living spider, centipede and insect to shreds. By shear weight of numbers, they down creatures one hundred times their size. Mounting the tree trunks and reaching the foliage, they send down showers of panic-stricken creatures to the ravenous warriors below. Thus they hunt all day, until sufficient food supplies have been obtained, when the army, burdened with spoils, returns to their temporary nest.

VISIT A BLESSING

Sometimes the house of man stands in the way of the attacking army, and as terrible as the results might be, should man remain within while the army passed, such visitations are really a blessing, for Army ants care nothing for the larder. They are after their natural prey, and spiders, roaches, bats and mice form a part of it. These are the pests of mankind, and the Army ants will rid his house of them in a few hours, more successfully than he ever could himself. When the Army ants arrive, one must simply move out. Should the visitation occur in the night, or during a storm, that is no concern of the army.

Now, as ever, they are under a mysterious supreme command, and no ant dares to disobey. What can be the form of communication that runs instantly through a million individuals? Here is where the ants have something that appears to outdo our radio, but I should not be at all surprised if the two forms of communication were fundamentally the same.

Readers' Forum

(*Continued from page* 53)

After both fish were thawed out, I placed them both in jars of water and left them in a warm place for ten hours. At the end of that time the fish were examined and found to be absolutely lifeless. They did not respond to artificial stimulation, using a current of ninety volts.

MURRAY GOLD,
Brooklyn, N. Y.

(This is only one of a number of letters which have come to the editor's attention in which the writers made a test case of the frozen fish article given in the September issue of SCIENCE AND INVENTION *Magazine. At that time Mr. Gernsback experimented with the artificial suspension of life in ice, in other words, attempted to produce artificial hybernation. The tests, however, were unsuccessful, and the conclusion was drawn that such a thing as artificial hybernation was impossible and that we doubted that fish could actually be frozen in ice and be made to survive, even though there were many articles in magazines citing such instances. The writer of the above letter took three fish and froze them and using one as a check, he was able to prove that the others were frozen solidly. He found that when the fish are so frozen they do not come back to life. We have had several reports to the effect that cat fish did come back to life. We wonder whether these tests were made with a check, and whether the writers of the letters can prove that the fish were actually frozen stiff. They should have been subjected to the same temperature for the same length of time before any attempts were made to thaw them out, and it would have been advisable to use fish of approximately the same weight.*

We wish to thank Mr. Gold and the many others who have found this article of sufficient interest to warrant experimenting with the suggestion advanced, for their kind reports of the results of their experimentation.—EDITOR.)

(*Continued on page* 93)

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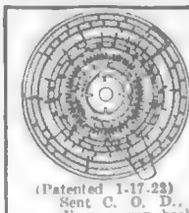

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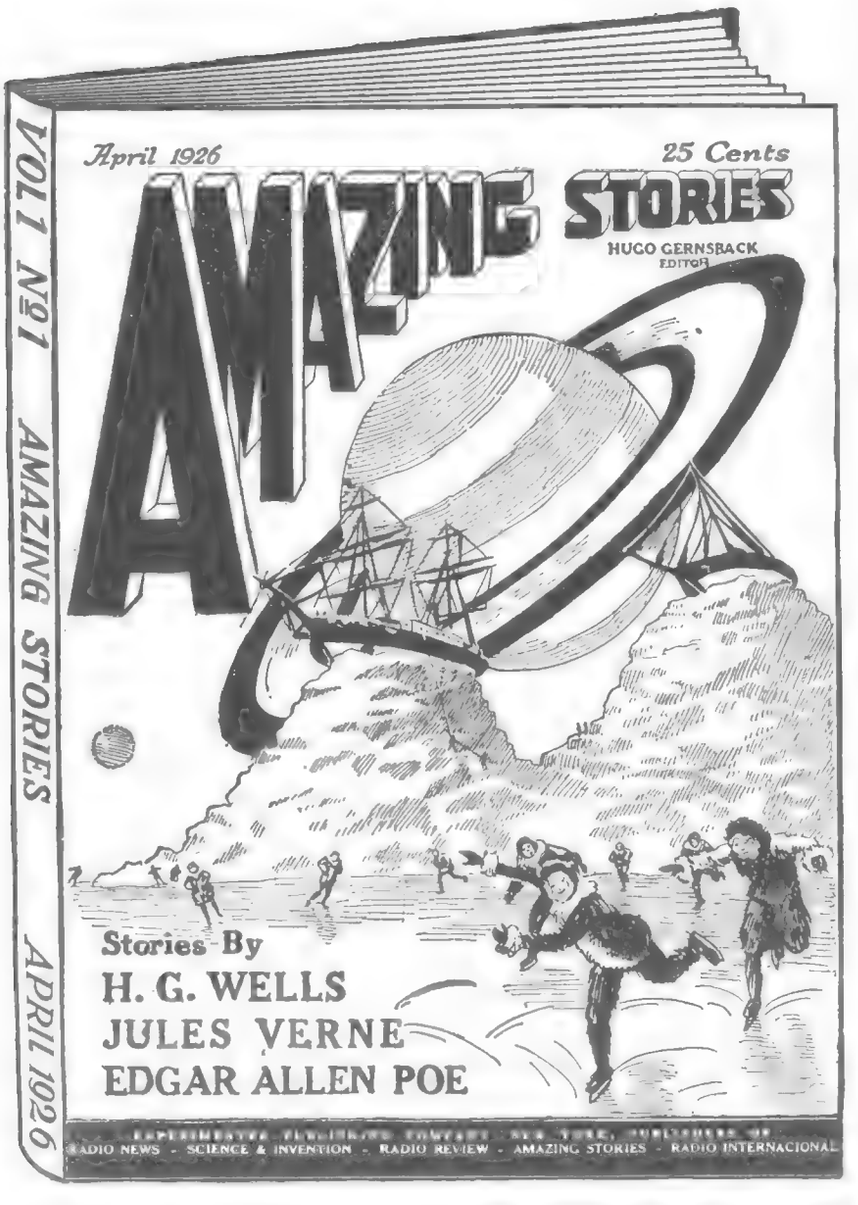

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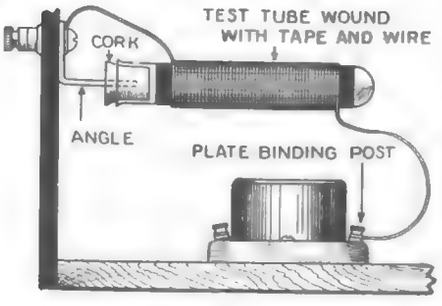
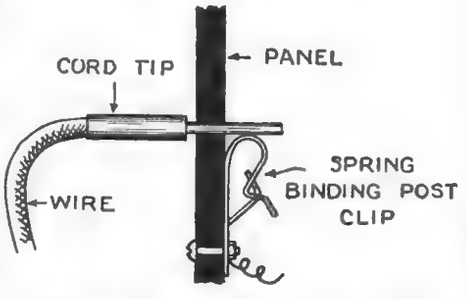


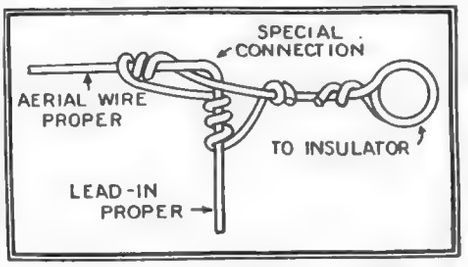
A radio frequency choke coil for use in Reinartz and similar sets and that can be easily mounted and placed out of the way may be constructed as shown above. This mounting also simplifies connections as one end of the coil goes directly to the plate binding post of the detector and the other to one of the phone binding posts.—Maurice E. Walker.

Cord-Tip Jack



A simple cord-tip jack may be made by mounting a spring type binding post such as shown above directly in back of a panel and drilling a small hole in the panel so that a cord tip thrust through the hole will press against the curved part of the binding post. This type of jack is both simple and efficient.—David Borovitz.

Solderless Aerial Connection



In order to avoid the necessity of making a soldered joint where the aerial and supporting wires join, use the special connection that is plainly illustrated above. Thus, the aerial wire is not cut into two pieces.—Toshihaiu Oka.

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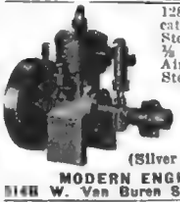

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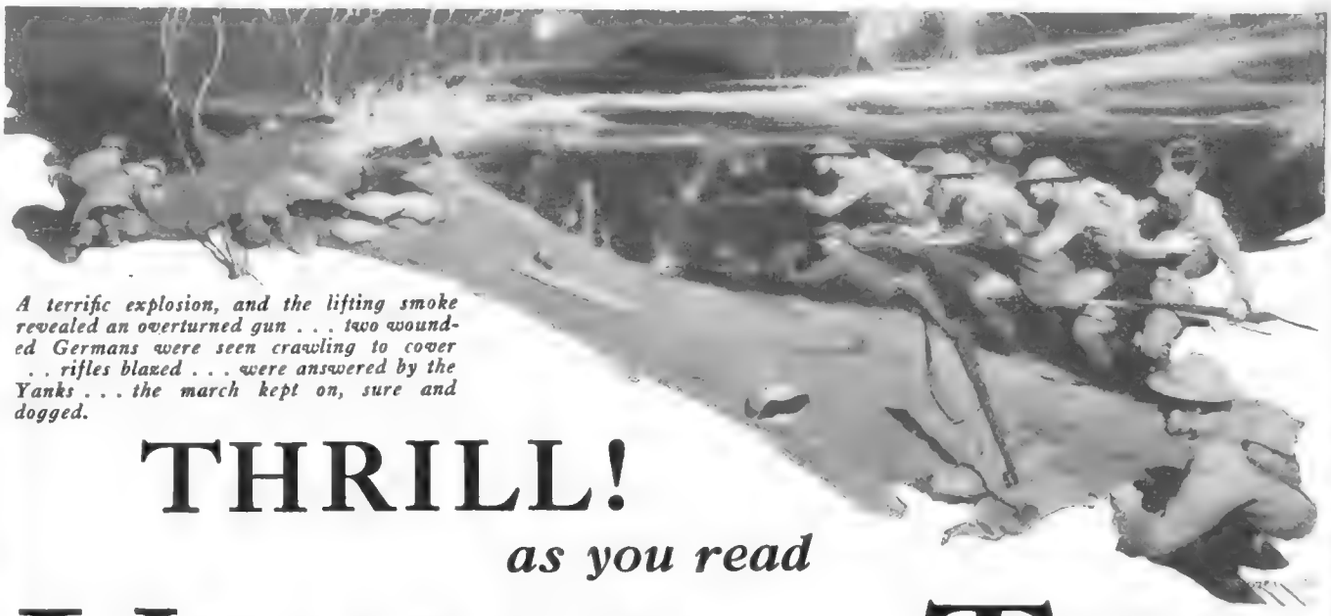

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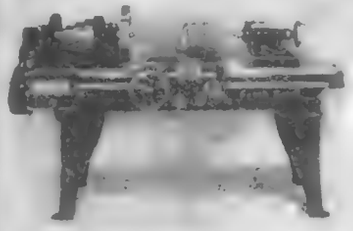

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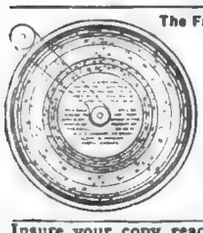

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The Radio Constructor

By LEON L. ADELMAN, 2AFS and ALFRED R. MARCY, 2DK

(*Continued from page 63*)

found entirely satisfactory for holding the wire and mounting together.

Note that the plug-and-jack method of mounting has been employed. This is the very best manner of mounting the coils so as to insure perfect contact and also to provide a quick means of changing from one wave-length band to another.

The plug is made from a short strip of spring brass, bent as shown in the sketch, Fig. 9. It is fastened to the insulating strip by means of a small machine screw to which is soldered one end of the winding.

The jack is simply a brass bushing whose dimensions can readily be understood from the drawing. It can be purchased in practically any radio store or 5 and 10 cent emporium. When the coil is plugged into its mounting, ascertain whether good contact is being established. The plug should be bent so that it must be forced into the jack.

When completed, the coils should be found very strong mechanically and to cover an unbroken range over the entire amateur wave-lengths.

Among the other parts that can be made is the radio frequency choke coil. It consists of 125 turns of number 36 S.S.C. wire on a cardboard tube 1 inch in diameter.

For short-wave reception, the grid leak is often found quite critical in value and if you have trouble in making the set oscillate properly or in controlling oscillation, employ a well made type of variable grid leak. One of the very best of these is the standard carbon pile type and with this instrument a resistance range of from one-quarter-megohm to ten megohms will be found. Adjust the value until the best reception is noted.

Note that the filaments of the tubes are automatically controlled by the output jack.

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The set has been found superior to anything that the authors have previously constructed and tested. It will be worth your time and trouble to duplicate it.

An Experimental "D" Coil Coupler

By HERBERT E. HAYDEN

(*Continued from page 61*)

has been completed a dowel stick or ¼-inch bakelite rod is attached by placing a screw through the hole drilled with the small drill, and fastening the end of the stick to the cardboard with this one screw.

Then slide a piece of insulating tubing ½ inch long and ¼ inch inside the diameter over the dowel stick. This is to act as a separator as will be noticed in Fig. 11.

After drilling a hole in a panel to accommodate a standard bushing, mount the coils as shown in Figs. 9 and 11.

As they appear in Fig. 9 the mutual induction is at a minimum, but by turning one coil in the field of the other as in Fig. 10 a gradual change is brought about, as at the start of rotation the 9-turn winding on one coil is opposite and in inductive relation to the one-turn winding of the other coil.

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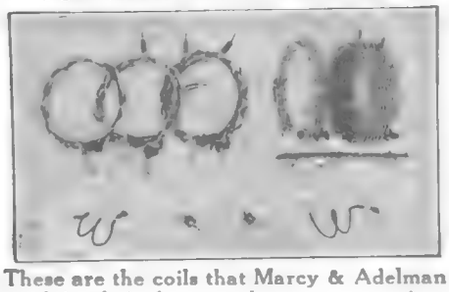

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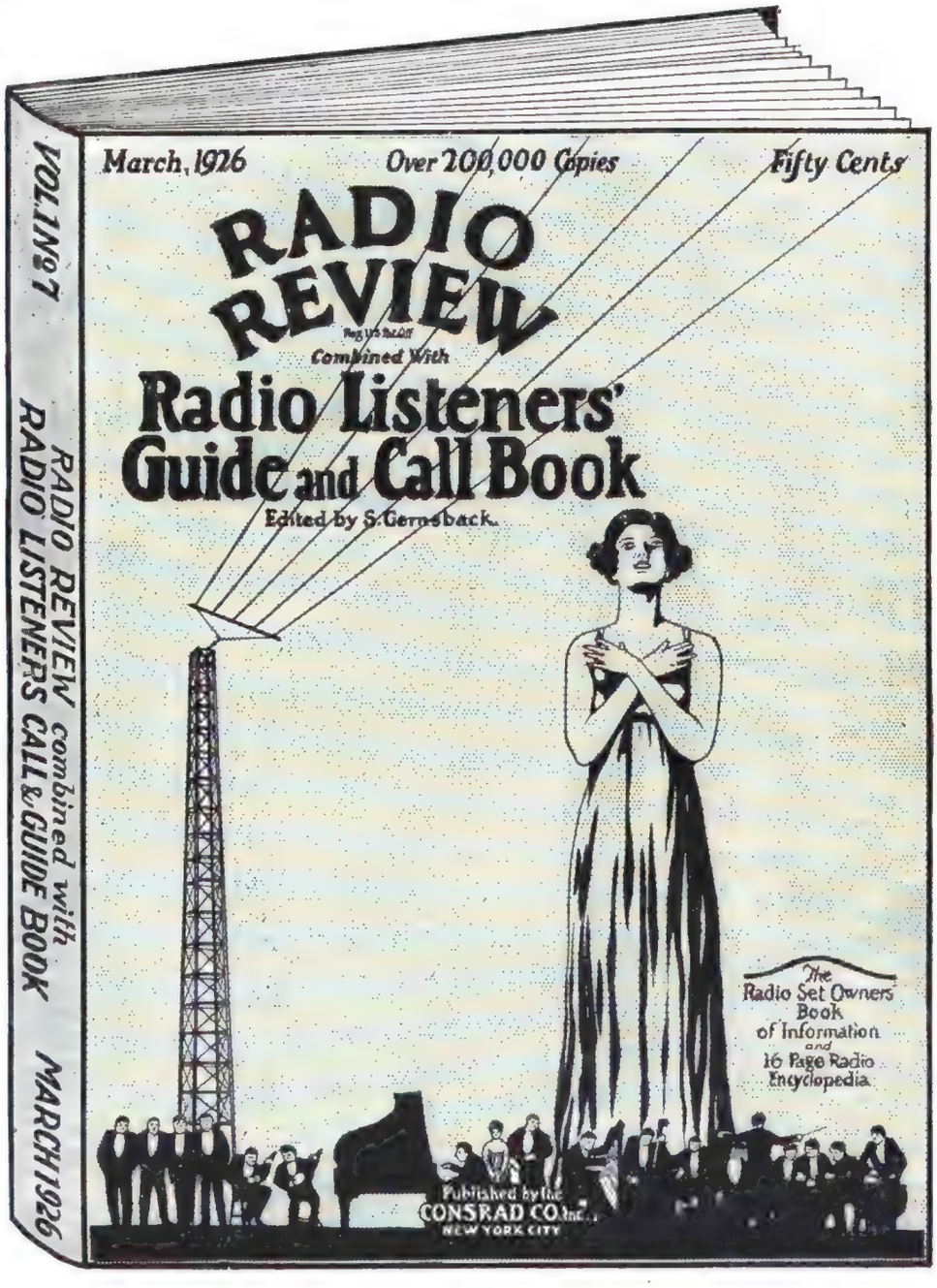
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able inductance as will be seen by referring to Fig. 11.

Of course many experiments can be performed with a cut out form of this type and the results are very satisfactory, and a coil of this kind can be made into a complete tuner. One coil could, for example, contain a primary and secondary winding; and the other coil, a tickler. In this case other notches than the one specified will probably be necessary, but the average experimenter can work this out to suit himself.

Another form of tuning unit would be the variometer, or for a single control compact set, a split-variometer winding.

This is especially valuable for the small portable summer sets, as it allows more space for additional vacuum tubes. It is not considered necessary to use varnish of any kind to cement the wires in place as they will not slip if the directions given have been followed.

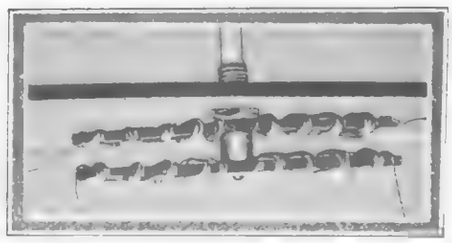

Fig. 11. A side view of the mounting of a D coil coupler showing the two coils, the shaft and the bushing.

Readers Forum

(*Continued from page* 87)

WHERE YOU WEIGH MOST

Editor, SCIENCE AND INVENTION:

Referring to page 804, issue of January, 1926, article by Ernest Brennecke, Jr., gives many interesting points but fails to mention some of the most important facts governing weight of objects on the earth. Allow me to enumerate some of these factors.

The centrifugal force caused by the rotation of the earth counteracts gravitation more in the tropics than near the poles.

All rocks below a few hundred feet below the sea level contain a uniform amount of moisture.

High mountains have a "pull up" on all things in the valleys between them. On the plains and oceanic islands the pull is all down.

Pressure on the interior of the earth increases clear to the center, and this pressure is such that at the depth of the deepest part of the ocean the very light gas Hydrogen would be reduced to a solid.

This pressure is so great that the movement of the rocks, if only for a few inches, creates heat enough to melt the rocks, so that, if an opening to the surface presents itself, they flow like water, and it takes them centuries to cool off. Such pressure must inevitably result in uniform density. WILLIAM F. FLETCHER, M.S.A.,
Parish, Florida.

(This interesting letter receives the following reply from Mr. Brennecke, who wrote the article.

"In reference to the article in the January number on the isostatic principle in the theory of gravitation, I would state that the points you bring up are of great importance and interest and certainly should appear in any general discussion of the factors governing the weight of objects. In the short space allotted to my article, however, it was obviously impossible to deal adequately with the whole subject. I merely aimed to make clear one principle, a principle which is at present being intensively investigated by the Division of Geodesy of the U. S. Coast and Geodetic Survey."

Another letter of great interest inasmuch as it was sent to Mr. Brennecke by Dr. William Bowie, Chief, Division of Geodesy of the U. S. Coast and Geodetic Survey, Department of Commerce, Washington, D. C., follows:

"I read with much interest your article on 'You Weigh Most on Ocean Islands,' which appeared in the January number of SCIENCE AND INVENTION *Magazine, and which indicates that you have a clear perception of the theory of isostasy. Thinking that you will be interested to see a paper of mine entitled, 'Geology from the Isostatic Viewpoint' which appeared in the Scientific Monthly for January, I am sending you a reprint of it herewith."*

Which only goes to prove that SCIENCE AND INVENTION *Magazine tries to be one hundred per cent. accurate in all things, and generally is.—*EDITOR.)

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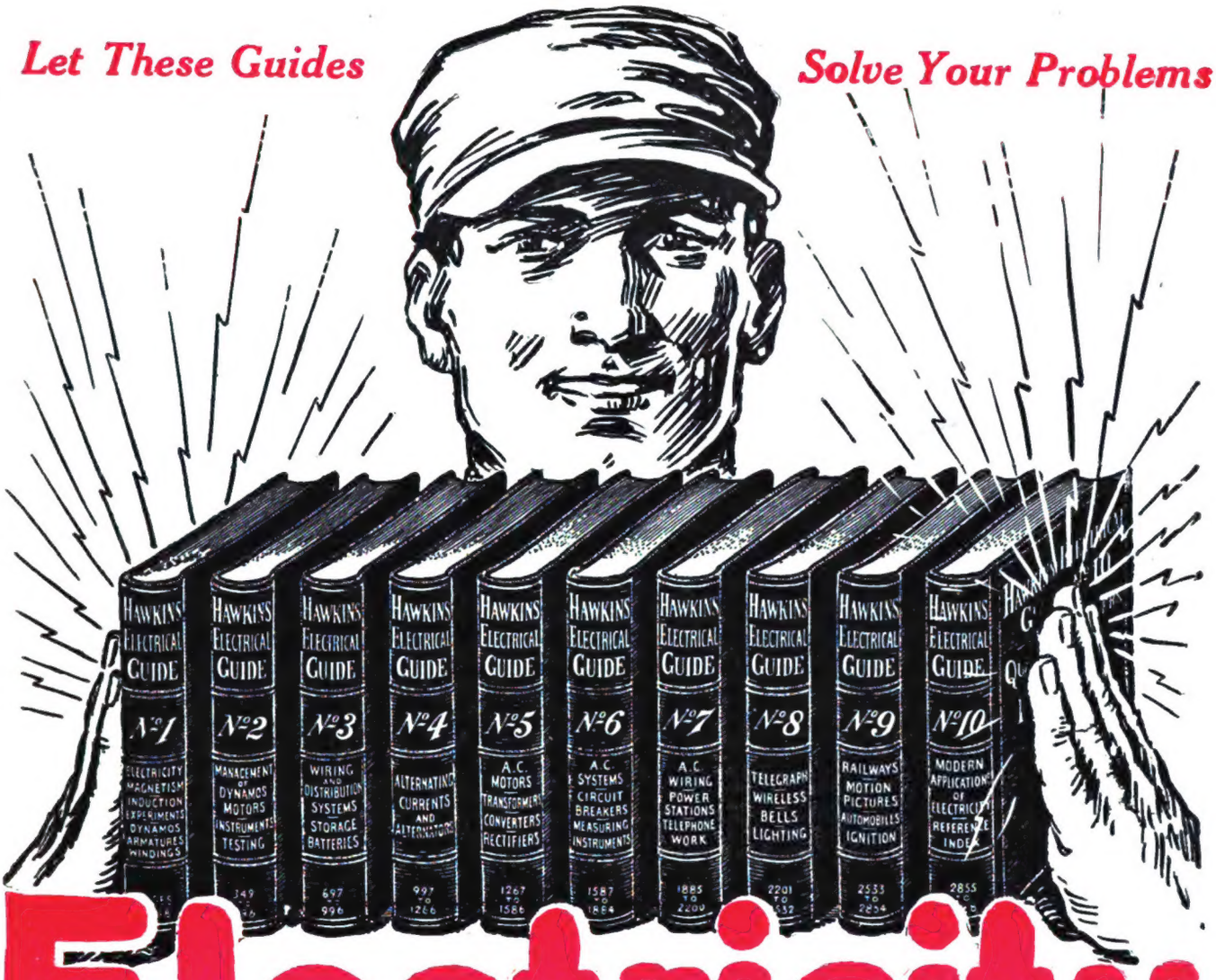

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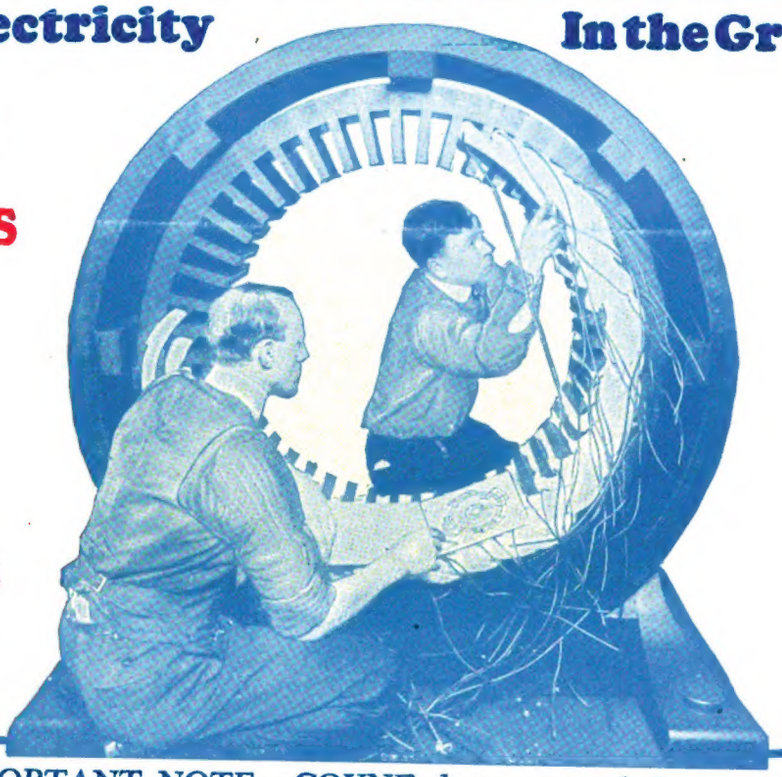

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